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(12) **United States Patent**
Conrad

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(54) **CONFIGURATION OF A SURFACE CLEANING APPARATUS**

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See application file for complete search history.

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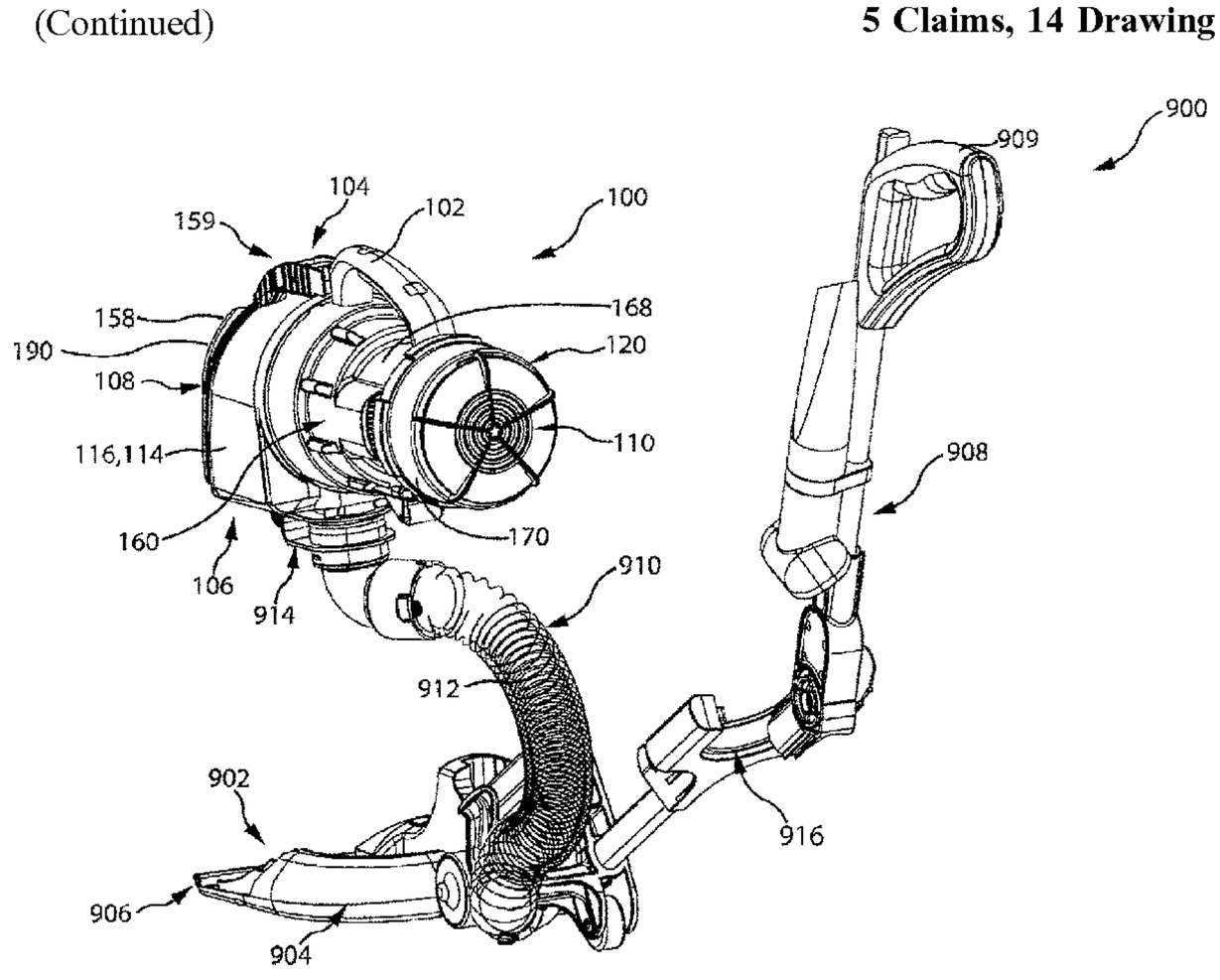
(57) **ABSTRACT**

A surface cleaning apparatus has a surface cleaning head having a pivoting connector, an upper end of the pivoting connector providing an air outlet of the surface cleaning head. A support consisting of an upflow duct is pivotally mounted to the surface cleaning head by the pivoting connector. A surface cleaning unit is vertically removably mounted to an upper end of the support. The surface cleaning unit comprises a cyclone unit, a pre-motor filter, a suction motor and flexible hose.

5 Claims, 14 Drawing Sheets



Related U.S. Application Data

continuation-in-part of application No. 14/036,818, filed on Sep. 25, 2013, now Pat. No. 9,301,662, which is a continuation of application No. 13/396,918, filed on Feb. 15, 2012, now Pat. No. 8,567,006, said application No. 14/475,219 is a continuation-in-part of application No. 12/721,128, filed on Mar. 10, 2010, now Pat. No. 8,950,039, which is a continuation-in-part of application No. 12/675,512, filed on Feb. 26, 2010, now abandoned, and a continuation-in-part of application No. 12/675,540, filed on Feb. 26, 2010, now Pat. No. 9,027,201, and a continuation-in-part of application No. 12/675,636, filed as application No. PCT/CA2008/001530, filed as application No. PCT/CA2008/001531, filed as application No. PCT/CA2008/001519, said application No. 13/396,918 is a continuation of application No. 11/954,310, filed on Dec. 12, 2007, now Pat. No. 8,166,607.

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(51) **Int. Cl.**

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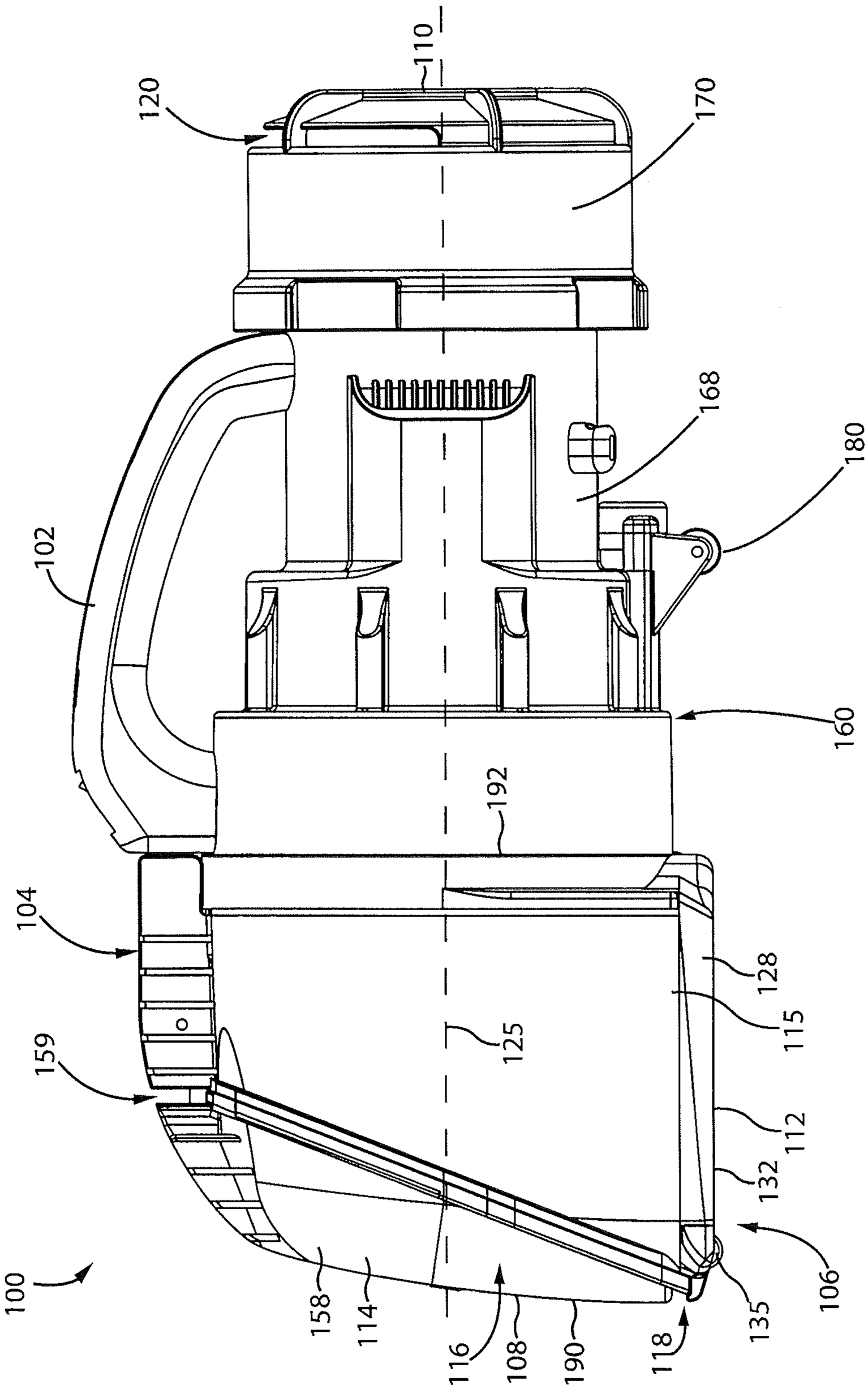
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Fig. 1

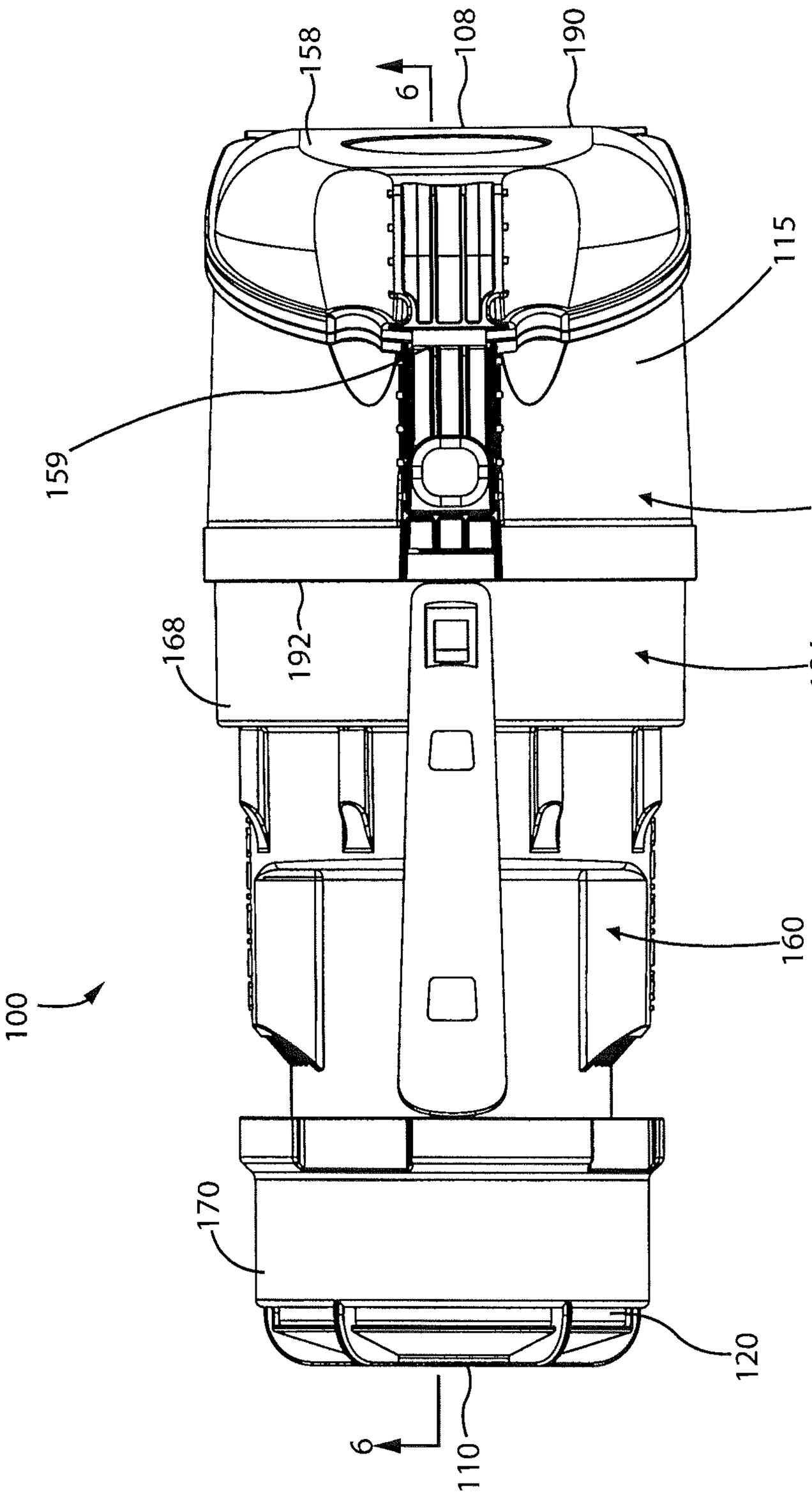

Fig. 2

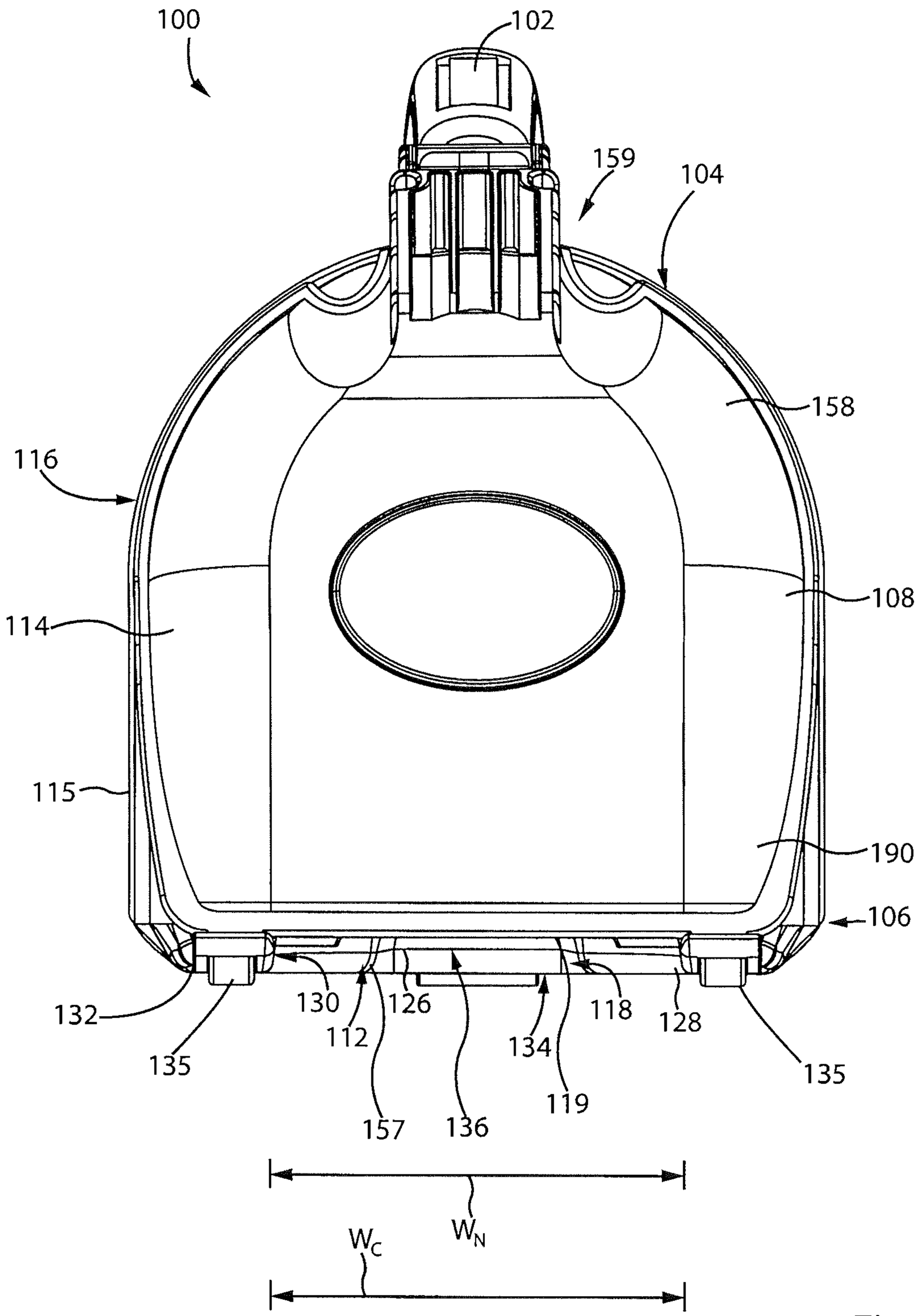
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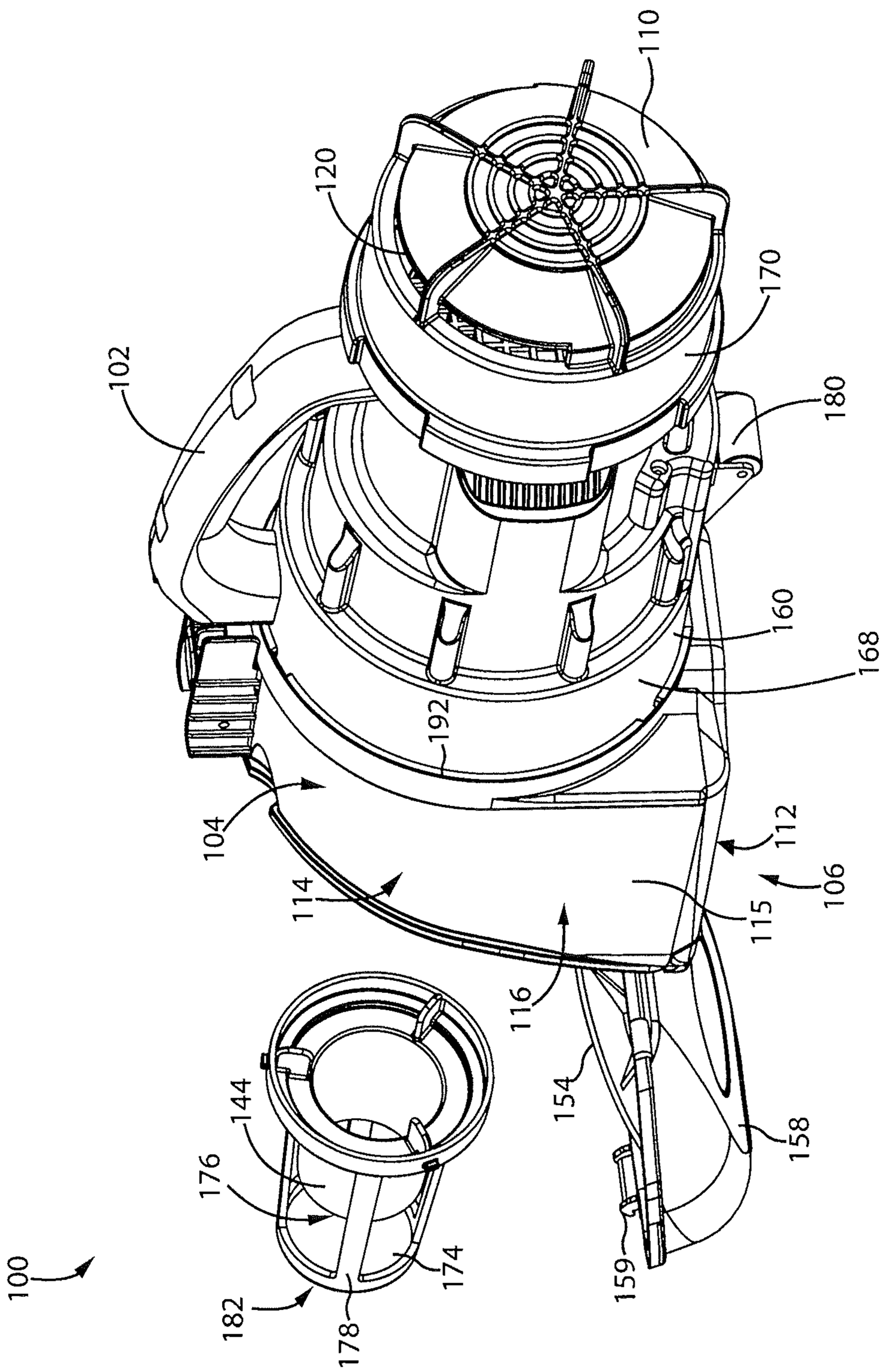
Fig. 3

Fig. 4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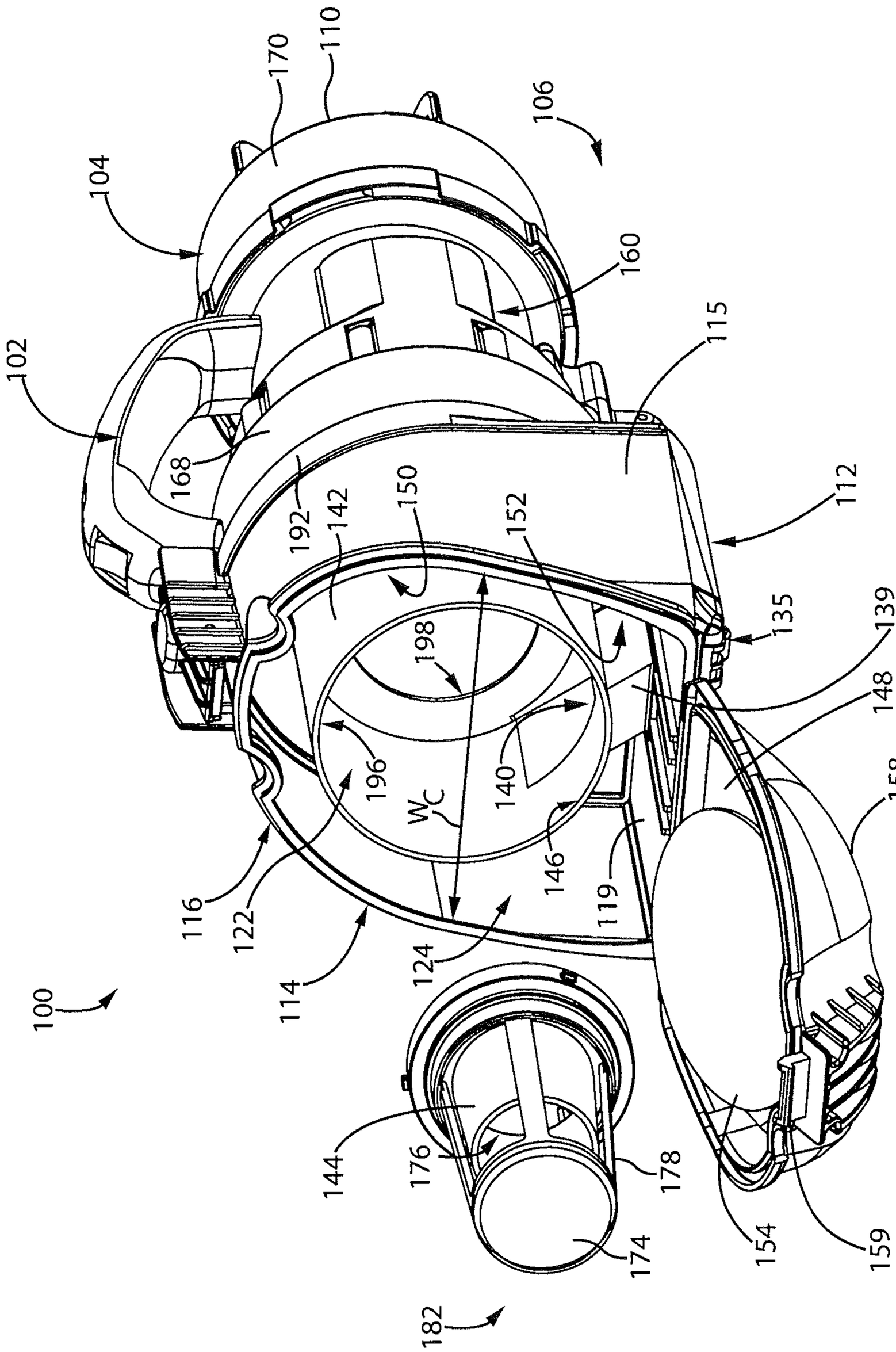
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Fig. 5

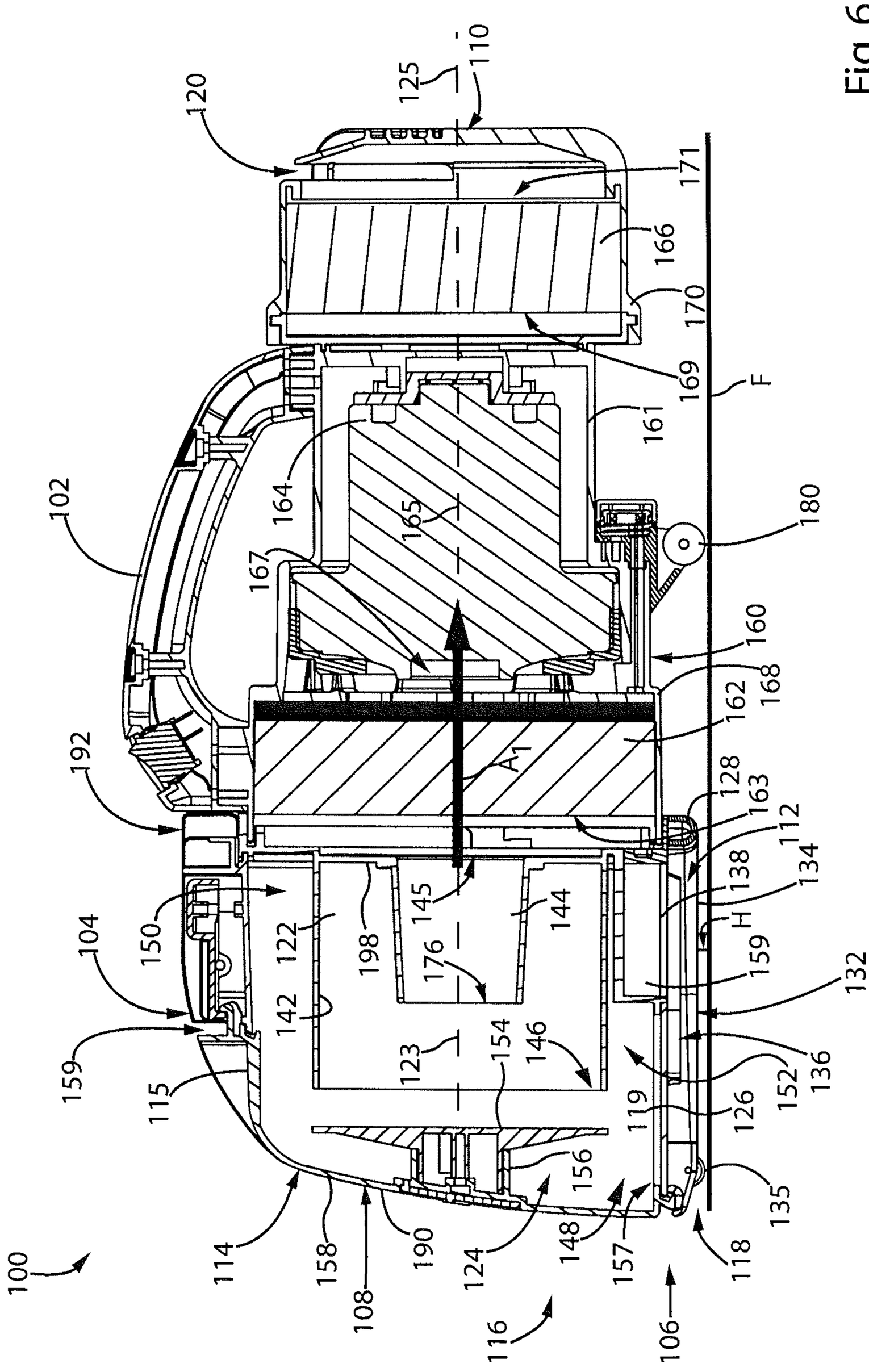
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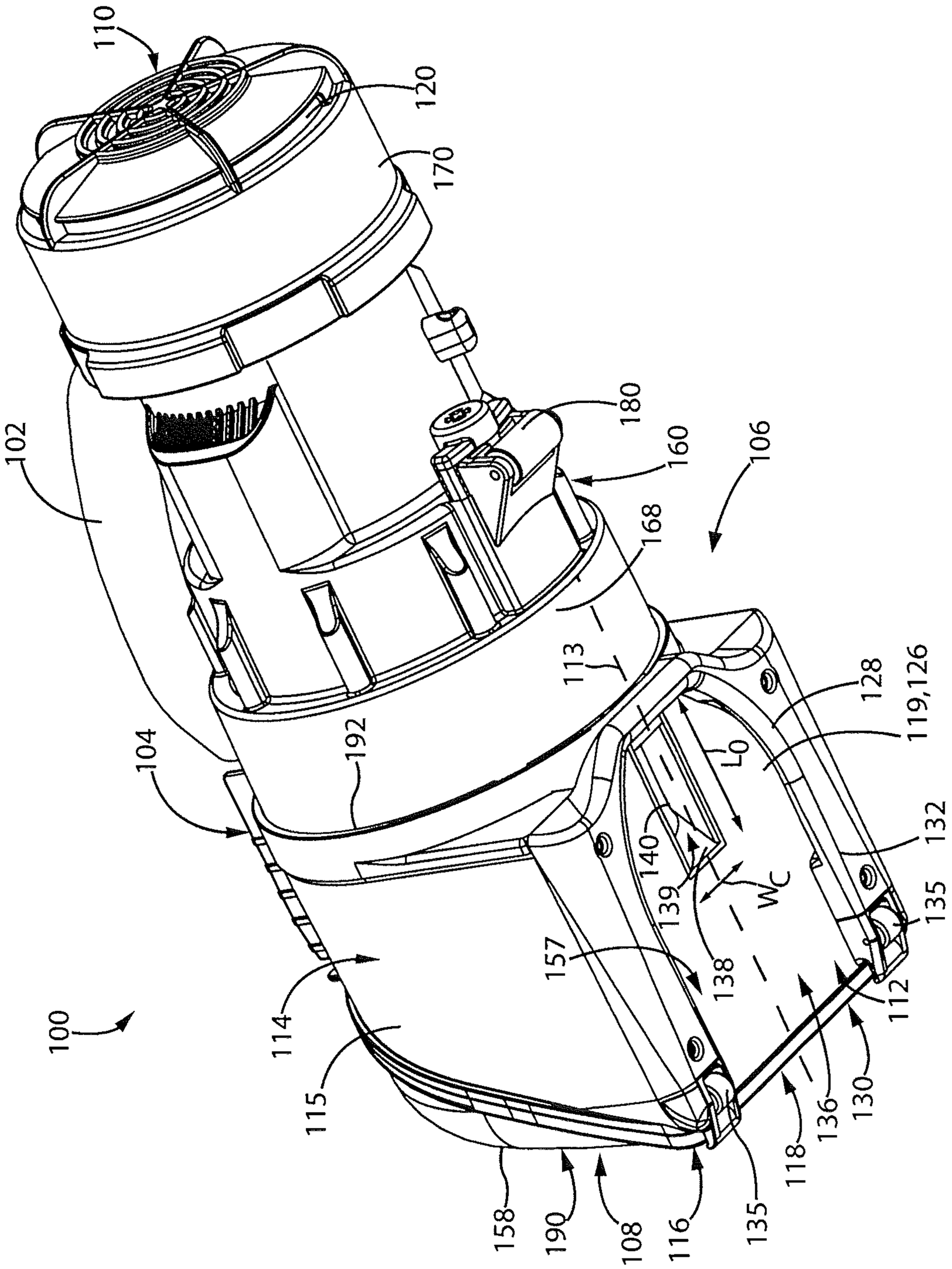
Fig.6

Fig. 7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W_C

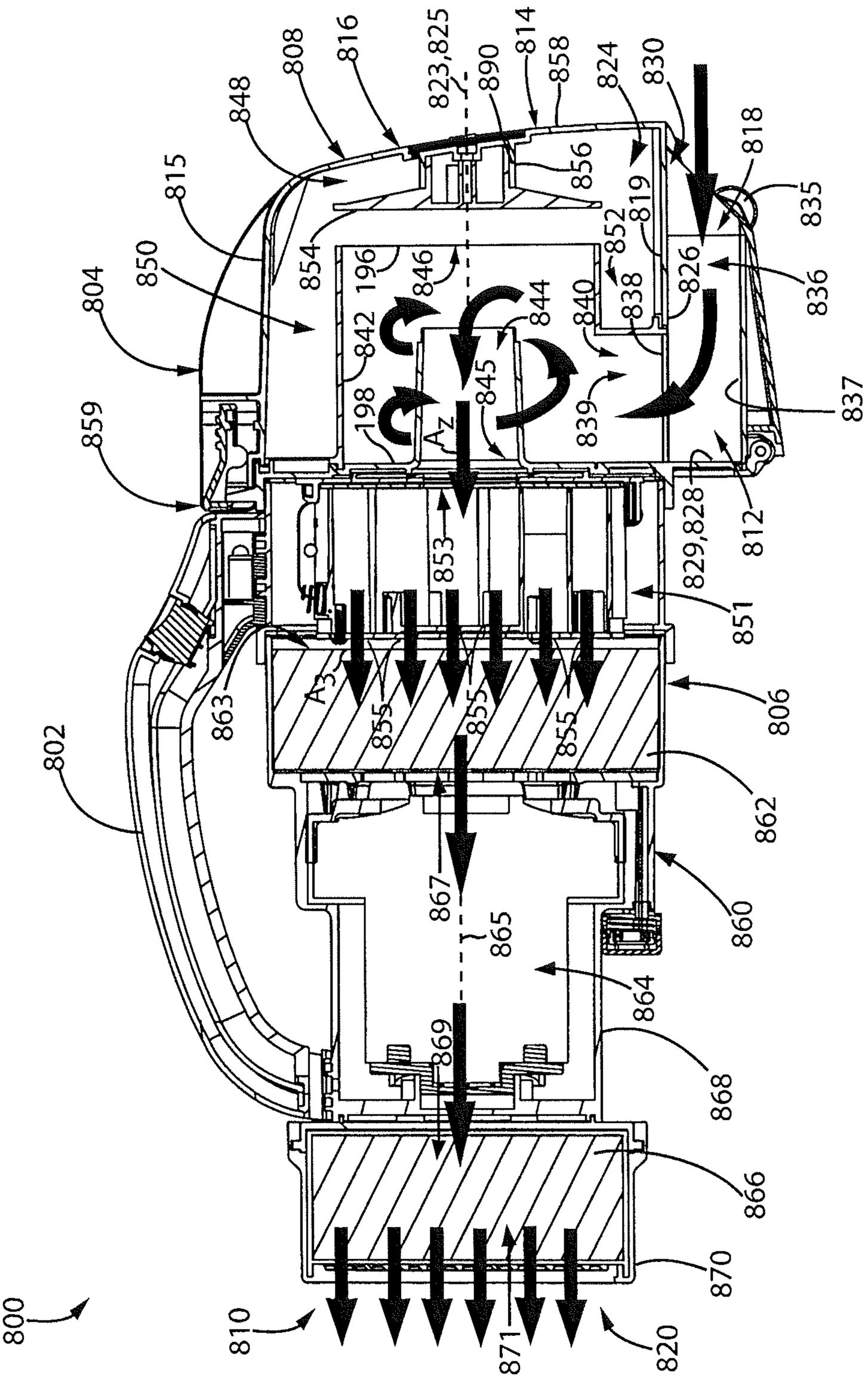
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Fig. 8

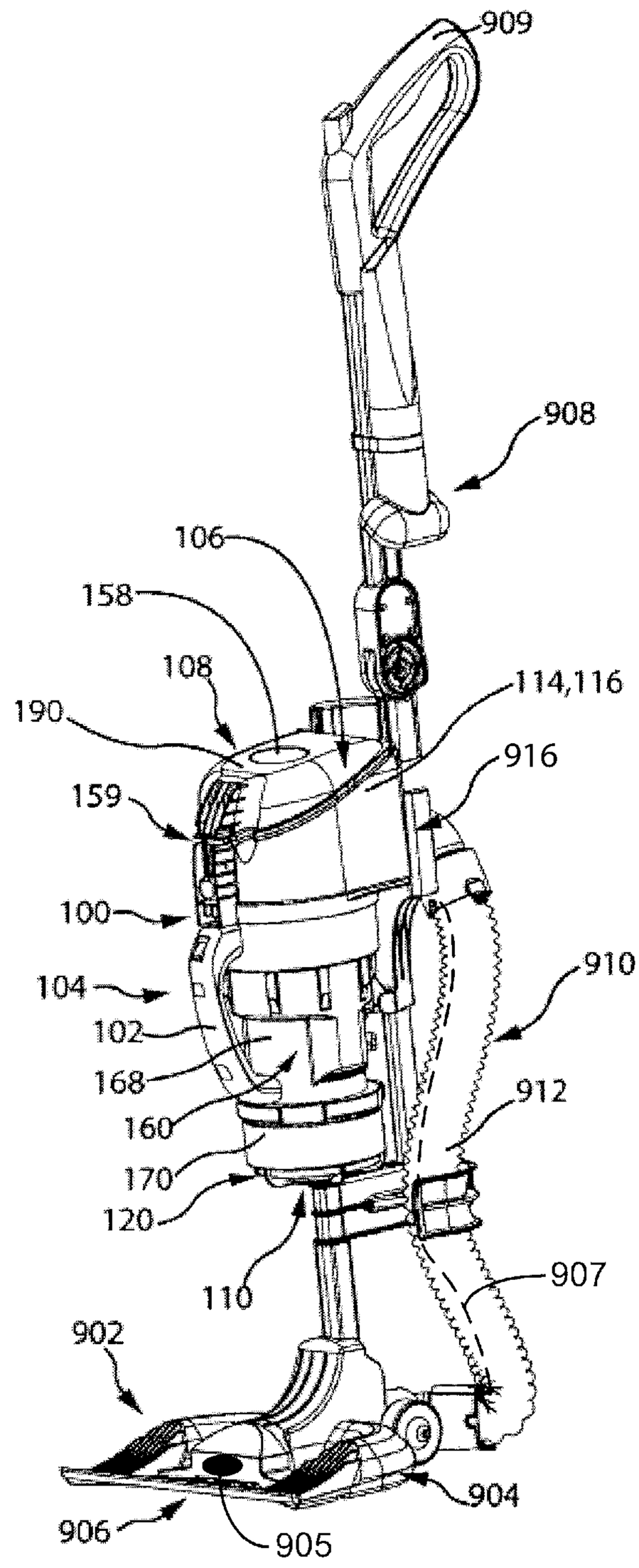
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Fig.9

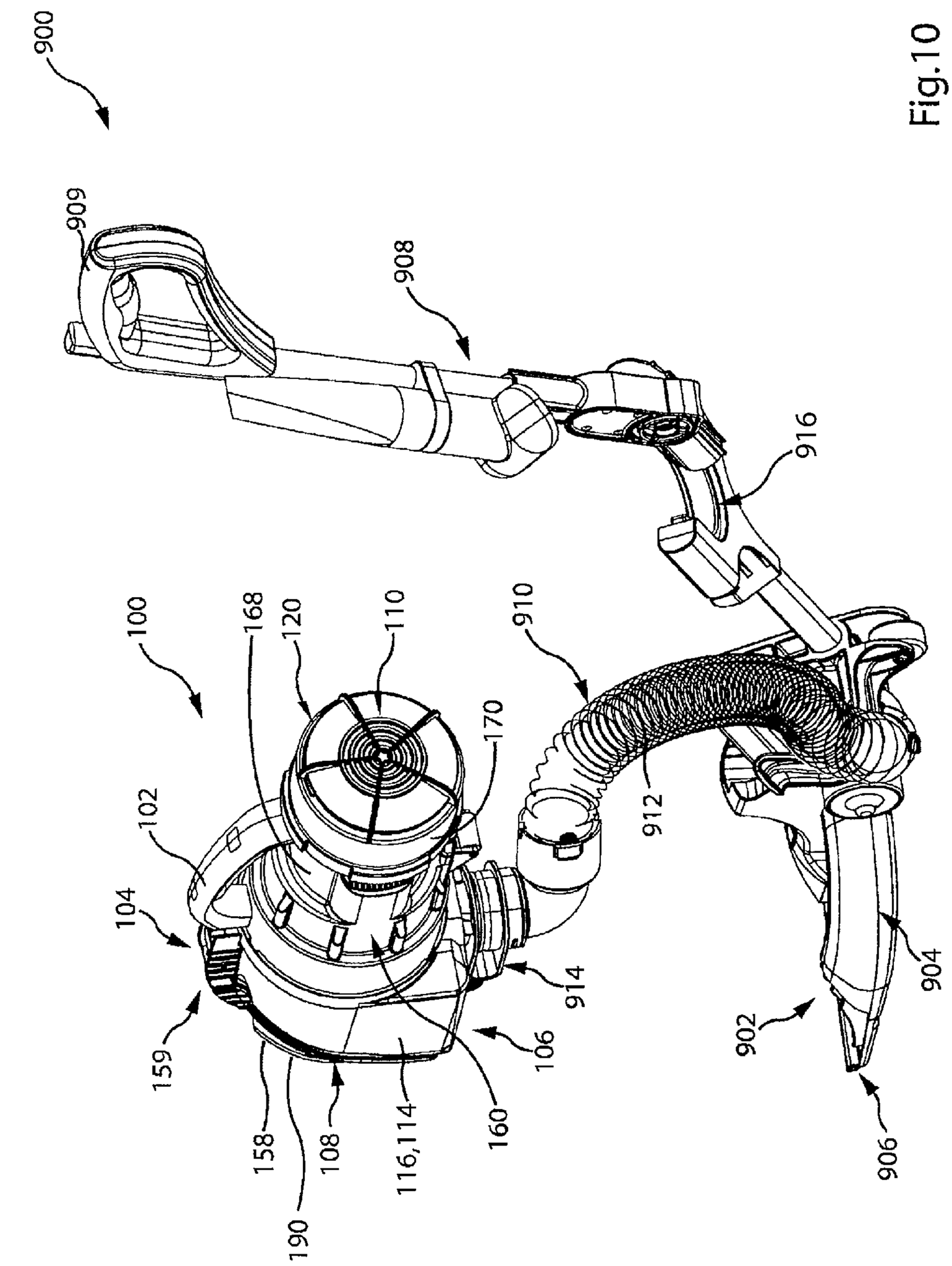
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Fig.10

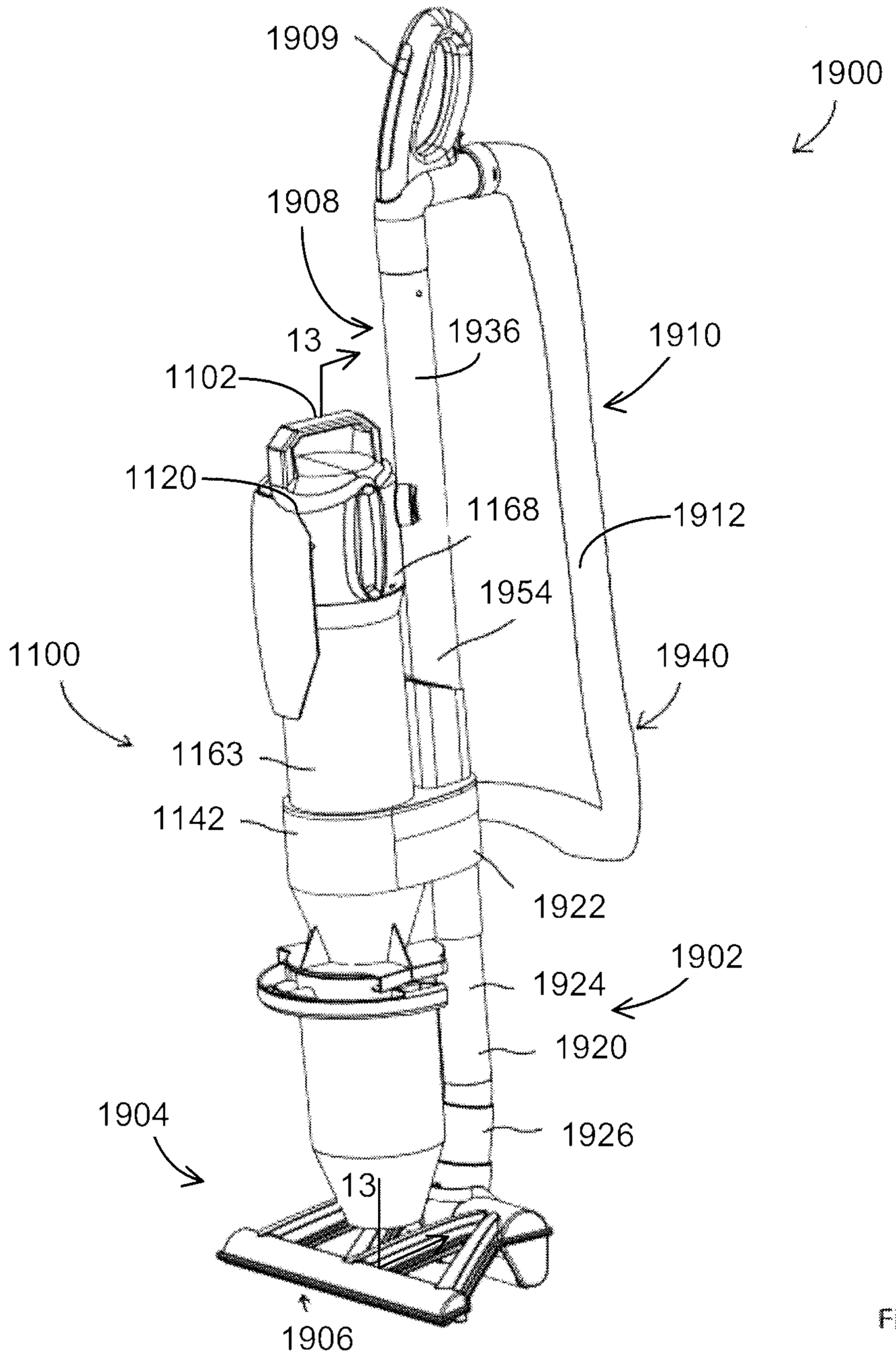
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Fig. 11

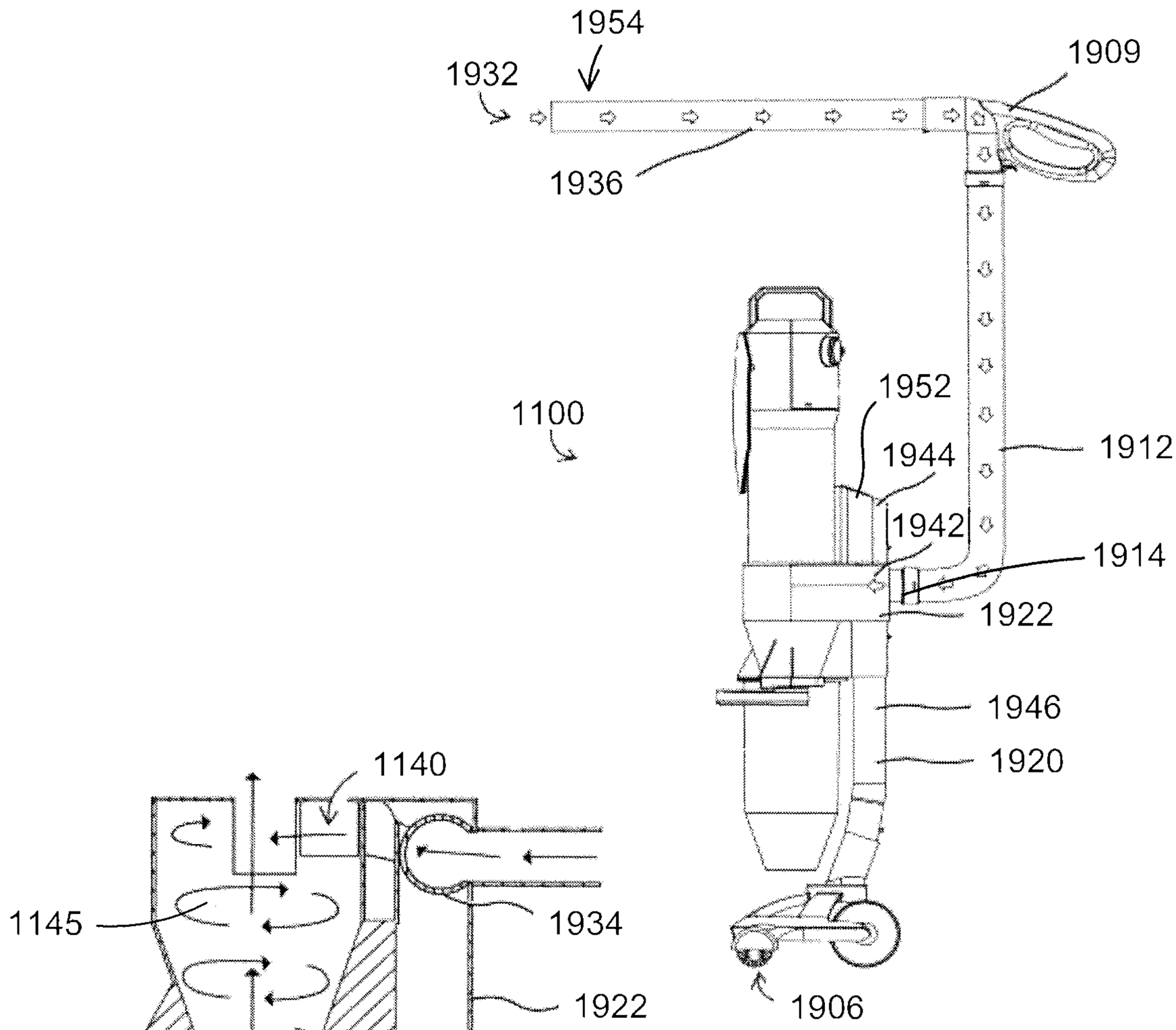
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Fig.14

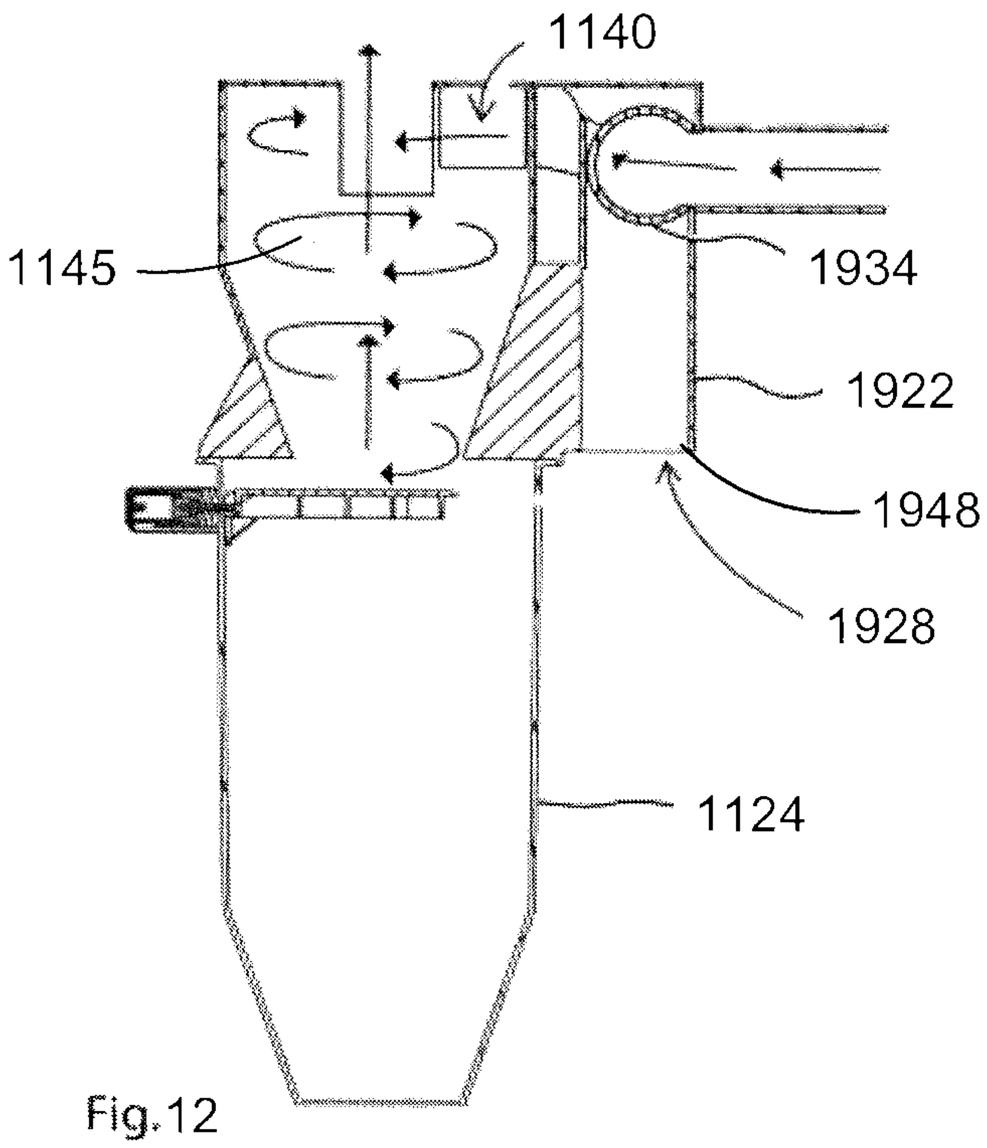
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Fig.12

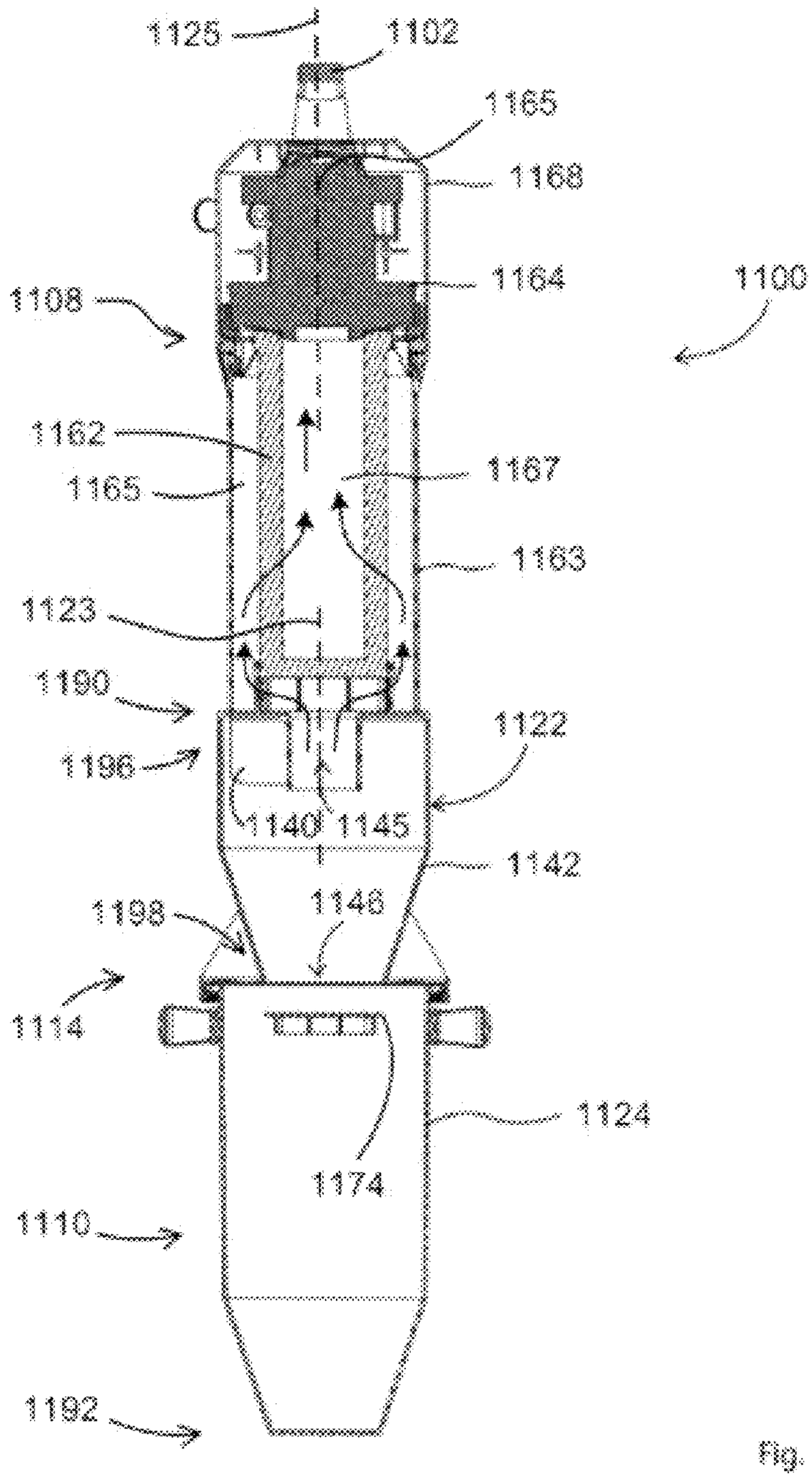
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Fig. 13

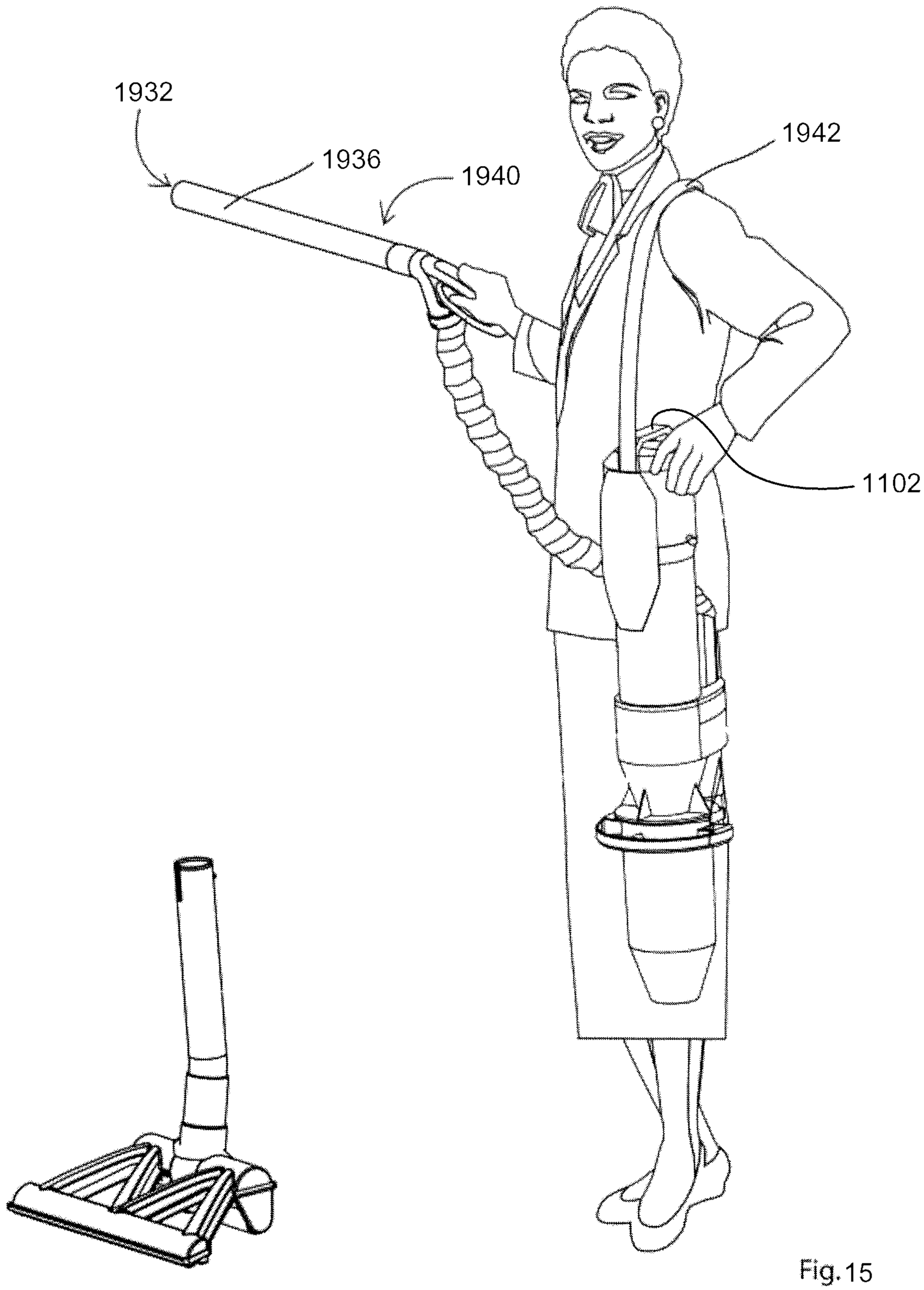

Fig.15

CONFIGURATION OF A SURFACE CLEANING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/475,219, filed on Sep. 2, 2014; and

(1) U.S. patent application Ser. No. 14/475,219 is a continuation-in-part of U.S. patent application Ser. No. 12/721,128, filed Mar. 10, 2010, entitled CONFIGURATION OF A SURFACE CLEANING APPARATUS, now U.S. Pat. No. 8,950,039 and claims the benefit of the filing date of Canadian Patent Application No. 2658005, filed Mar. 11, 2009, entitled CONFIGURATION OF A SURFACE CLEANING APPARATUS, which itself is

(a) a continuation-in-part of U.S. patent application Ser. No. 12/675,512 filed Feb. 26, 2010 entitled CYCLONIC SURFACE CLEANING APPARATUS WITH A SPACED APART IMPINGEMENT SURFACE, which is abandoned and which was a national phase entry of PCT/CA2008/001531 which claimed priority from CA2,599,303; and is

(b) a continuation-in-part of U.S. patent application Ser. No. 12/675,540 filed on Feb. 26, 2010 entitled CYCLONIC SURFACE CLEANING APPARATUS WITH EXTERNALLY POSITIONED DIRT CHAMBER now U.S. Pat. No. 9,027,201 and which was a national phase entry of PCT/CA2008/001530 which claimed priority from CA2,599,303; and is

(c) a continuation-in-part of U.S. patent application Ser. No. 12/675,636 filed Feb. 26, 2010 entitled CYCLONIC SURFACE CLEANING APPARATUS WITH SEQUENTIAL FILTRATION MEMBERS which is abandoned and which was a national phase entry of PCT/CA2008/001519 which claimed priority from CA2,599,303;

(2) and U.S. patent application Ser. No. 14/475,219 is also a continuation-in-part of U.S. patent application Ser. No. 14/036,818 filed on Sep. 25, 2013, now U.S. Pat. No. 9,301,662 which itself is a continuation of application Ser. No. 13/396,918, filed on Feb. 15, 2012, now U.S. Pat. No. 8,567,006, which is a continuation of application Ser. No. 11/954,310, filed on Dec. 12, 2007, now U.S. Pat. No. 8,166,607, which claims priority from U.S. provisional application No. 60/869,586, filed on Dec. 12, 2006

each of which is incorporated herein by reference in its entirety.

FIELD

The specification relates to surface cleaning apparatus such as vacuum cleaners. In a preferred embodiment, the specification relates to cyclonic hand vacuum cleaners.

INTRODUCTION

The following is not an admission that anything discussed below is prior art or part of the common general knowledge of persons skilled in the art.

PCT publication WO 2008/009890 (Dyson Technology Limited) discloses a handheld cleaning appliance comprising a main body, a dirty air inlet, a clean air outlet and a cyclonic separator for separating dirt and dust from an airflow. The cyclone separator is located in an airflow path leading from the air inlet to the air outlet. The cyclonic separator is arranged in a generally upright orientation (i.e., the air rotates about a generally vertical axis in use). A base surface of the main body and a base surface of the cyclonic separator together form a base surface of the appliance for supporting the appliance on a surface. See also PCT publication WO 2008/009888 (Dyson Technology Limited) and PCT publication WO 2008/009883 (Dyson Technology Limited).

U.S. Pat. No. 7,370,387 (Black & Decker Inc.) discloses a hand-holdable vacuum cleaner that uses one or more filters and/or cyclonic separation device. and means for adjusting an angle of air inlet relative to a main axis of said vacuum cleaner. In particular, the vacuum cleaner further comprises a rigid, elongate nose having the air inlet at one end thereof, the nose being pivotal relative to a main axis of the vacuum cleaner through an angle of at least 135 degrees.

SUMMARY

The following introduction is provided to introduce the reader to the more detailed discussion to follow. The introduction is not intended to limit or define the claims

According to one broad aspect, a surface cleaning apparatus and, preferably a cyclonic hand vacuum cleaner and/or a surface cleaning unit that is removably mounted to an upright support structure that is pivotally mounted to a cleaning head is provided wherein at least part, and preferably a substantial portion, of the air flow path between components of the surface cleaning apparatus is linear. Accordingly, one or more components of the vacuum cleaner may be arranged such that the air outlet of an upstream component faces the air inlet of a downstream component. In a preferred embodiment, the outlet from a cyclone is oriented such that the air may travel generally linearly to the inlet of a suction motor. This may be achieved by orienting the axis of a cyclone such that the cyclone axis is generally parallel to the axis of the suction motor. If the hand vacuum cleaner has more than one cyclonic stage, then the outlet of the last pre-motor cyclone or cyclones is preferably oriented such that the air may travel generally linearly to the inlet of a suction motor. It will be appreciated that one or more pre-motor filters may be positioned between the cyclone outlet and the suction motor inlet. Preferably, the air flow through the pre-motor filter or filters is generally linear. It will be appreciated that the air outlet of other components (e.g., a cyclone, filter or suction motor) may also be oriented such that the air may travel generally linearly to the inlet of the next downstream component (e.g., a cyclone, filter or suction motor).

An advantage of this design is that the backpressure in the airflow path through the hand vacuum cleaner may be reduced. Accordingly, the airflow rate through the hand vacuum cleaner may be increased without increasing the size (and weight) of the suction motor. Alternately, or in addition, a smaller motor may be used with decreasing the airflow rate through the hand vacuum cleaner.

In accordance with one broad aspect of the teachings described herein, a hand vacuum cleaner can include a front end and a rear end, an air flow passage extending from a dirty air inlet to a clean air outlet and a first cyclone unit positioned in the air flow passage. The first cyclone unit can include at least one cyclone having a cyclone inlet and an outlet passage positioned in the cyclone chamber that has a direction of flow and at least one dirt collection chamber. A pre-motor filter may be positioned in the air flow passage downstream from the outlet passage, and a suction motor may be positioned in the air flow passage downstream from the pre-motor filter. The air flow passage may include an air

flow path portion that extends from the outlet passage to the clean air outlet. The air flow path portion may be generally linear, and the at least one cyclone may have a cyclone axis extending longitudinally through the at least one cyclone. The hand vacuum cleaner may have an axis extending from the front end to the rear end and the cyclone axis is generally parallel to the axis of the hand vacuum cleaner.

The at least one cyclone may have a cyclone axis extending longitudinally through the at least one cyclone. The suction motor may have a motor axis extending generally parallel to the axis of rotation of a suction fan and the cyclone axis is generally parallel to the motor axis.

The dirt collection chamber may have an openable door provided at a front end of the first cyclone unit.

The at least one cyclone may have a cyclone front end, a cyclone rear end and the cyclone air inlet and the cyclone air outlet may be at the same end of the at least one cyclone.

The cyclone air inlet and the cyclone air outlet may be at the cyclone rear end.

The at least one dirt collection chamber may be openable when mounted to the hand vacuum cleaner.

The pre-motor filter may be positioned facing the outlet passage and having a pre-motor filter air inlet and a pre-motor filter air outlet, the suction motor has a motor axis extending generally parallel to the axis of rotation of a suction fan and the pre-motor filter air inlet and the pre-motor air outlet are generally transverse to the motor axis.

A post motor filter may have a post motor filter air inlet and a post motor filter air outlet. The suction motor may have a motor axis extending generally parallel to the axis of rotation of a suction fan and the post motor filter air inlet and the post motor filter air outlet are generally transverse to the motor axis.

The pre-motor filter may have a pre-motor filter air inlet and a pre-motor filter air outlet and the hand vacuum cleaner further comprises a post motor filter having a post motor filter air inlet and a post motor filter air outlet, and the pre-motor filter air inlet, the pre-motor air outlet, the post motor filter air inlet and the post motor air outlet may be aligned.

The hand vacuum cleaner may also include a post motor filter positioned downstream from the suction motor and comprising an air outlet at the rear end of the hand vacuum cleaner.

The first cyclone unit may consists essentially of a single cyclone and a single dirt collection chamber.

The hand vacuum cleaner may include comprising a second cyclone unit downstream from the first cyclone unit.

The second cyclone unit may have a second cyclone air inlet having a direction of flow and a second cyclone air outlet having a direction of flow and the direction of flow through the second cyclone air inlet and the second cyclone air outlet may be in the same direction as the direction of air flow through the outlet passage.

The at least one cyclone may have a cyclone axis extending longitudinally through the at least one cyclone and air exiting the clean air outlet travels in a direction that is generally parallel to the cyclone axis.

In accordance with another broad aspect of the teachings describe herein, which may be used along or in combination with any other aspects, a surface cleaning apparatus may include an air flow passage extending from a dirty air inlet to a clean air outlet, a floor cleaning unit comprising a surface cleaning head and a handle drivingly connected thereto and a surface cleaning unit removably mounted to the floor cleaning unit. The surface cleaning unit may include a first cyclone unit positioned in the air flow passage. The first cyclone unit may include at least one cyclone comprising a cyclone inlet, a cyclone axis and an axially extending outlet conduit and at least one dirt collection chamber. A pre-motor filter may be positioned in the air flow passage downstream from the conduit. A suction motor may be positioned in the air flow passage downstream from the pre-motor filter. The air flow passage may include a first air flow path portion that extends from the outlet conduit to the suction motor, wherein the air flow path portion is generally linear, and a second air flow path portion comprising a flexible conduit providing air flow communication between the surface cleaning head and the surface cleaning unit when the surface cleaning unit is mounted to the floor cleaning unit and removable with the surface cleaning unit when the surface cleaning unit is removed from the floor cleaning unit.

The surface cleaning unit may be operable when removed from the floor cleaning unit.

The first cyclone unit may have a portion that is openable or removable and the portion is located at an upper end of the first cyclone unit.

The surface cleaning unit may be removably mounted to the handle.

The surface cleaning unit may include a first end, a second end axially spaced apart from the first end and a side wall extending between the first and second ends, and may also include a cleaning unit handle extending from the sidewall.

The first cyclone unit may have a first end wall at the first end and wherein at least a portion of the first end wall is openable to empty the dirt collection chamber.

The surface cleaning apparatus may also include a second end wall at the second end and wherein the second end wall comprises the clean air outlet.

Air exiting the suction motor may travel in a direction that is generally linear with the first air flow path portion.

The surface cleaning apparatus may include a post motor filter and the air flow path from a suction motor outlet to a post motor filter inlet is generally linear and axial with the first air flow path portion.

Air exiting the post motor filter may travel in a direction that is generally linear with the first air flow path portion.

The flexible conduit may include an electrified stretch hose providing an electrical connection between the surface cleaning unit and the surface cleaning head.

In accordance with another broad aspect of the teachings described herein, which may be used alone or in combination with any other aspects, a upright surface cleaning apparatus may include an air flow passage extending from a dirty air inlet to a clean air outlet, a floor cleaning unit having a surface cleaning head and a handle drivingly connected thereto, and a first cyclone unit supported by the handle and in the air flow passage. The first cyclone unit may include at least one cyclone comprising a cyclone inlet, an internal conduit extending in a first direction and defining an outlet passage and at least one dirt collection chamber. A pre-motor filter may be positioned in the air flow passage downstream from the internal conduit. A suction motor may be downstream from the pre-motor filter and the air flow passage may include an air flow path portion that extends from the internal conduit to the suction motor, wherein the air flow path portion that is generally linear and wherein air exiting the clean air outlet travels in a direction that is generally parallel to the first direction.

The cyclone unit may be mounted to the handle and the suction motor may be supported by the handle below the first cyclone unit.

The cyclone unit may be mounted to a suction motor housing.

The air flow passage may include a portion extending from the surface cleaning head to the first cyclone unit and the portion comprises a flexible conduit.

The first cyclone unit may have a portion that is openable or removable and the portion is located at an upper end of the first cyclone unit.

In accordance with another broad aspect of the teachings described herein, which may be used alone or in combination with another aspect, a surface cleaning apparatus comprising may include an air flow passage extending from a dirty air inlet to a clean air outlet, a floor cleaning unit comprising a surface cleaning head and a handle drivingly connected thereto and a surface cleaning unit removably mounted to the floor cleaning unit. The first cyclone unit may include a first cyclone unit positioned in the air flow passage. The first cyclone unit may include at least one cyclone comprising a cyclone inlet, a cyclone axis and an axially extending air outlet conduit and at least one dirt collection chamber. A pre-motor filter may be positioned in the air flow passage downstream from the conduit. A suction motor may be positioned in the air flow passage downstream from the pre-motor filter. The motor may include a motor axis that is substantially parallel to the cyclone axis. The air flow passage may include a first air flow path portion that extends from the air outlet conduit to the suction motor wherein air exiting the air outlet conduit travels in the axial direction and air entering the suction motor travels in the axial direction, and a second air flow path portion comprising a flexible conduit providing air flow communication between the surface cleaning head and the surface cleaning unit when the surface cleaning unit is mounted to the floor cleaning unit and removable with the surface cleaning unit when the surface cleaning unit is removed from the floor cleaning unit.

The first air flow path portion may include a pre-motor filter chamber containing the pre-motor filter, and may be linear.

It will be appreciated that the vacuum cleaner may incorporate one or more of the features of each of these examples.

DRAWINGS

In the detailed description, reference will be made to the following drawings, in which:

FIG. **1** is a side plan view of an example of a surface cleaning unit;

FIG. **2** is a top plan view of the surface cleaning unit of FIG. **1**;

FIG. **3** is a front plan view of the surface cleaning unit of FIG. **1**;

FIG. **4** is a partially exploded rear perspective view of the surface cleaning unit of FIG. **1**;

FIG. **5** is a partially exploded front perspective view of the surface cleaning unit of FIG. **1**;

FIG. **6** is a cross section taken along line **6-6** in FIG. **2**;

FIG. **7** is a bottom perspective view of the surface cleaning unit of FIG. **1**,

FIG. **8** is a cross section showing an alternate example of a surface cleaning unit;

FIG. **9** is a perspective illustration of the surface cleaning unit of FIG. **1** mounted in a surface cleaning apparatus;

FIG. **10** is a perspective illustration of the surface cleaning unit of FIG. **1** in airflow communication with the surface cleaning apparatus of FIG. **9**;

FIG. **11** is a perspective illustration of another example of a surface cleaning apparatus;

FIG. **12** is a cross-sectional view of a portion of the surface cleaning apparatus of FIG. **11**;

FIG. **13** is another cross-sectional view of a portion of the surface cleaning apparatus of FIG. **11**, taken along line **13-13** in FIG. **11**;

FIG. **14** is a side view of the surface cleaning apparatus of FIG. **11** in an above floor cleaning configuration; and

FIG. **15** is a perspective view of the surface cleaning apparatus of FIG. **11** in another floor cleaning configuration.

DESCRIPTION OF VARIOUS EXAMPLES

Various apparatuses or methods will be described below to provide an example of each claimed invention. No example described below limits any claimed invention and any claimed invention may cover processes or apparatuses that are not described below. The claimed inventions are not limited to apparatuses or processes having all of the features of any one apparatus or process described below or to features common to multiple or all of the apparatuses described below. It is possible that an apparatus or process described below is not an embodiment of any claimed invention.

In the drawings attached hereto, the hand vacuum cleaner is exemplified as comprising one or two cyclonic stages. It will be appreciated that the vacuum cleaner **100** may be of various configurations (e.g., different positioning of the cyclonic stages and the suction motor and differing cyclonic stages that may comprise one or more cyclones and one or more filters).

Referring to FIGS. **1** to **7**, a first example of a surface cleaning unit **100** is shown. In the embodiment shown, the surface cleaning unit **100** (also referred to herein as vacuum cleaner **100** or cleaner **100**) is usable as a vacuum cleaner **100**, and more particularly a hand vacuum cleaner **100**. The vacuum cleaner **100** is movable along a surface to be cleaned by gripping and maneuvering handle **102**. The vacuum cleaner includes an upper portion **104**, a lower portion **106**, a front end **108**, and a rear end **110**. A longitudinal axis **125** of the vacuum cleaner **100** extends between the front end **108** and the rear end **110**. In the example shown, handle **102** is provided at the upper portion **104**. In alternate examples, handle **102** may be provided elsewhere on the vacuum cleaner **100**, for example at the rear **110** and may be of any design.

In the example shown, the vacuum cleaner **100** comprises a nozzle **112** and a cyclone unit **114**, which together preferably form a surface cleaning head **116** of the vacuum cleaner **100**. In the example shown, the surface cleaning head **116** is preferably provided at the front end **108** of the vacuum cleaner **100**.

Nozzle **112** engages a surface to be cleaned, and comprises a dirty air inlet **118**, through which dirty air is drawn into the vacuum cleaner **100**. An airflow passage extends from the dirty air inlet **118** to a clean air outlet **120** of the cleaner **100**. In the example shown, clean air outlet **120** is at the rear **110** of the cleaner **100**.

Cyclone unit **114** is provided in the airflow passage, downstream of the dirty air inlet **118**. Cyclone unit **116** has a front end **190**, and a rear end **192**. In the example shown, the cyclone unit **114** is a one piece assembly comprising one cyclone **122**, and one dirt collection chamber **124**, which are integrally formed. In alternate examples, as will be described hereinbelow with respect to FIG. **8**, the cyclone unit **110** may include more than one cyclonic stage, wherein

each cyclonic stage comprises one or more cyclones and one or more dirt chambers. Accordingly, the cyclones may be arranged in parallel and/or in sequence. Further, in alternate examples, the cyclone **122** and dirt collection chamber **124** may be separately formed.

In the example shown, the nozzle **112** is positioned at the lower portion **106** of the vacuum cleaner **100**. Preferably, as exemplified, nozzle **112** is positioned at the bottom of the vacuum cleaner **100**, and, preferably, beneath the cyclone unit **114**. However, it will be appreciated that nozzle **112** may be connected to the cyclone unit or dirt collection chamber at alternate locations.

Preferably, as exemplified, nozzle **112** may be on lower surface **157** of cyclone unit **114** and may share a wall with the cyclone unit **114**. For example, in a particularly preferred design, the upper wall **126** of the nozzle **112** may be a lower wall of the cyclone unit **114**. As shown in FIG. **6**, dirt chamber **124** surrounds the lower portion of cyclone **122**. Accordingly, the upper wall of nozzle **112** may be part of the lower wall of the dirt chamber. It will be appreciated that if dirt chamber **124** does not extend around the lower portion of cyclone **122**, then the upper wall of nozzle **112** may be part of a lower wall of cyclone **122**.

Preferably, in the example shown, the nozzle **112** is fixedly positioned at the lower portion **106** of the vacuum cleaner **100**. That is, the nozzle **112** is not movable (e.g., rotatable) with respect to the remainder of the vacuum cleaner **100**, and is fixed at the lower portion **106** of the vacuum cleaner **100**.

As shown in FIGS. **3** and **5**, nozzle **112** has a width W_N, and cyclone unit **114** has a width W_C. In the example shown, W_N, and W_C are about the same. An advantage of this design is that the nozzle **112** may have a cleaning path that is essentially as wide as the hand vacuum itself.

Preferably, nozzle **112** comprises an airflow chamber **136** wherein at least a portion, and preferably a majority, of the lower surface **134** of the chamber is open. In an alternate design as exemplified by FIG. **8**, nozzle **812** comprises a lower wall **837**, which closes lower end **834**. Accordingly, nozzle **112** may be of various designs and may be an open sided passage or a closed passage. In either embodiment, it will be appreciated that nozzle **112** may be mounted or provided on cyclone unit **114** and as exemplified on a lower portion of the dirt collection chamber so as to be removable with the dirt collection chamber

An open sided design is exemplified in FIG. **7**A wherein nozzle **112** comprises an upper nozzle wall **126**. In the example shown, the upper nozzle wall **126** comprises a portion **119** of a wall **115** of the cyclone unit.

Preferably, one or more depending walls **128** extend downwardly from the upper nozzle wall **126**. The depending wall is preferably generally U-shaped. In one embodiment, a depending wall **128** is provided rearward of opening **138**. In other embodiments, depending walls may alternately or in addition be provided on the lateral sides of opening **138**. It is preferred that the depending walls may be continuous to define a single wall as shown, or may be discontinuous. The depending walls may be provided on each lateral side of opening **138** and rearward thereof. Further, depending walls **128** may extend a substantial distance to the front end **108** and, preferably, essentially all the way to front end **108**. The depending wall **128** may be continuous to define a single wall as shown, or may be discontinuous. The depending wall is preferably rigid (e.g., integrally molded with cyclone unit **114**). However, they may be flexible (e.g., bristles or rubber) or moveably mounted to cyclone unit **114** (e.g., hingedly mounted).

Preferably, the lower end **132** of depending wall **128** is spaced above the surface being cleaned when the hand vacuum cleaner is placed on a surface to be cleaned. As exemplified in FIG. **6**, when vacuum cleaner **100** is placed on a floor F, lower end **132** of depending wall **128** is spaced a distance H above the floor. Preferably distance H is from 0.01 inches to 0.175 inches, more preferably from 0.04 to 0.08 inches.

The height of the depending wall **128** (between upper nozzle wall **126** and lower end **132**) may vary. In some examples, the depending wall may have a height of between about 0.05 and about 0.875 inches, preferably between about 0.125 and about 0.6 inches and more preferably between about 0.2 and about 0.4 inches. The height of depending wall **128** may vary but is preferably constant.

As exemplified, the open end of the U-shape defines an open side **130** of the nozzle **114**, and forms the dirty air inlet **118** of the cleaner **100**. In the example shown, the open side **130** is provided at the front of the nozzle **114**. In use, when optional wheels **135** are in contact with a surface, the open side **130** sits above and is adjacent a surface to be cleaned (e.g. floor F). As mentioned hereinabove, preferably, lower end **132** of depending walls **128** is spaced above floor F. Accordingly, some air may enter nozzle **114** by passing underneath depending wall **132**. In such a case, the primary air entry to nozzle **114** is via open side **130** so that dirty air inlet **118** is the primary air inlet, with a secondary air inlet being under depending wall **128**.

In the example shown, the lower end **132** of the depending wall **128** defines an open lower end **134** of the nozzle **114**. The open lower end **134** preferably extends to the front **108** of the cleaner **100**, and merges with the open side **130**. In use, the exemplified nozzle **112** has an open lower end **134** that faces a surface to be cleaned.

In the example shown, a plurality of wheels **135** are mounted to the depending wall **128**, and extend lower than the lower end **132** of the depending wall **128**. Accordingly, in use, when wheels **135** are in contact with a surface, the lower end **132** of the depending wall **128** is spaced from the surface to be cleaned, and the space between the lower end of the depending wall **128** and the surface to be cleaned form the secondary dirty air inlet to the vacuum cleaner **100**. It will be appreciated that wheels **135** are optional. Preferably, wheels **135** are positioned exterior to the airflow path through nozzle **112**, e.g., laterally outwardly from depending wall **128**. Preferably a pair of front wheels **135** are provided. Preferably, the wheels are located adjacent front **108**. Optionally, one or more rear wheels **180** may be provided. In an alternate embodiment, no wheels may be provided.

The upper nozzle wall **126**, depending wall **128**, and open lower end **134** of the nozzle **112** define open sided airflow chamber **136** of the nozzle. In use, when wheels **135** are in contact with a horizontal surface, the nozzle **112** and the airflow chamber **136** preferably extend generally horizontally, and preferably linearly along a nozzle axis **113** (see FIG. **7**).

An opening **138** maybe provided in the upper nozzle wall **126**, and is in communication with the airflow chamber **136**. Opening **138** may be of any size and configuration and at various locations in upper nozzle wall **126**. In use, when wheels **135** are in contact with a surface, the opening **138** faces a surface to be cleaned, air enters the dirty air inlet **118**, passes horizontally through the airflow chamber **136**, and passes into the opening **138**. Opening **138** is in communication with a cyclone inlet passage **139**, which is in communication with a cyclone inlet **140** of cyclone **122**.

As exemplified in FIGS. **1-7**, a single cyclone is used. As exemplified therein, the direction of air exiting the outlet of cyclone **122** is the same as the direction of airflow immediately upstream of the suction motor **164**. Further, while an optional pre-filter **162** is positioned between the cyclone air outlet **145** and the suction motor **162**, the front and rear face of the pre-motor filter are each preferably transverse to the direction of airflow leaving the cyclone outlet **145**. Further, the direction of airflow through the pre-motor filter **162** is preferably in the same direction as the air leaving the cyclone outlet **145**. Accordingly, in this preferred embodiment, while the air may spread out or converge as it travels through the pre-motor filter **162**, some and preferably all of the air continues to generally travel in the same direction, namely rearwardly.

It will be appreciated that cyclone **122** may of any configuration and orientation. Preferably, cyclone **122** comprises a chamber wall **142**, which in the example shown, is cylindrical. The cyclone chamber is located inside chamber wall **142**. The cyclone **122** extends along an axis **123**, which, in the example shown, is preferably parallel to the nozzle axis, and/or preferably parallel to the cleaner axis **125**. Axis **123** preferably extends generally horizontally when cleaner **100** is in use and wheels **135** are seated on a surface. Cyclone **122** has a front end **196**, and a rear end **198**. In the example shown, the front end **196** of the cyclone **122** is proximate the front end **108** of the vacuum cleaner **100**.

Preferably, the cyclone air inlet **140** and the cyclone air outlet **145** are at the same end of the cyclone **122** and the dirt outlet **146** is at an opposed end. The cyclone air outlet **145** may be covered by a screen or shroud or filter as is known in the art. As exemplified, the cyclone air inlet **140** is defined by an aperture in the chamber wall **142**. The cyclone inlet **140** is preferably at the rear end **198** of the cyclone **122**. As can be seen in FIG. **5**, the inlet passage **139** is configured such that air enters the cyclone **122** in a tangential flow path, e.g., passage **139** may be arcuate. The air travels in a cyclonic path in the cyclone **122**, and dirt in the air is separated from the air. The air exits the cyclone via an outlet passage **144**, through outlet **145**. Outlet **145** is preferably at the rear end **198** of the cyclone. Accordingly, inlet **140** and outlet **145** are at the same end of the cyclone.

As exemplified in FIG. **6**, a plate **174** may be provided adjacent outlet passage **144**, spaced from and facing the inlet **176** to outlet passage **144**. Plate **174** may be mounted to cyclone **122** via legs **178**. In the example shown, plate **174**, and legs **178** form an assembly **182** that is removably mounted in cyclone **122**. In some examples, a screen may be mounted around legs **178**.

The dirt that is separated from the air exits the cyclone via dirt outlet **146**, and enters dirt collection chamber **124**. Dirt outlet is preferably at the front **196** of the cyclone **122**, and further, is at the front end **108** of the cleaner **100**. The dirt collection chamber **124** may be internal or external to the cyclone chamber. Preferably, as exemplified, the dirt collection chamber is external. The dirt collection chamber **124** may be in communication with the cyclone chamber **122** by any means known in the art. Accordingly, one or more dirt outlets may be provided. Preferably, the dirt outlet is at the end opposed to the air inlet and, preferably, the dirt outlet is at the front end **108**.

In the example shown, dirt collection chamber **124** preferably comprises two portions. A first portion **148** is provided immediately adjacent the dirt outlet **146**, and is at the front end **108** of the cleaner **100**. A second portion **150** is concentric with the cyclone **122**. A lower portion **152** of the second portion **150** is below the cyclone. As exemplified, nozzle **112** is positioned below first portion **148**, and lower portion **152**. Accordingly, dirt chamber **124** may comprise an annular chamber surrounding the cyclone **122**.

A separation plate **154** may be provided in the dirt collection chamber **124**, and may be mounted in facing relation to the dirt outlet **146**. The separation plate **154** aids in preventing dirt in dirt chamber **124** from re-entering cyclone **122**. Preferably, plate **154** is spaced from dirt outlet **146**. Plate **154** may be mounted by any means to any component in cyclone unit **114**. As exemplified, the separation plate may be mounted on an arm **156**, which extends from a front wall **158** at the front end **190** of the cyclone unit **114**.

Cyclone unit **114** may be emptied by any means known in the art. For example, one of the ends of the cyclone unit **114** may be openable and/or removable. The end may open cyclone chamber as well as the dirt collection chamber. As exemplified in FIGS. **4** and **5**, front wall **158** is pivotally mounted to the cyclone unit wall **115**, and provides an openable door of the cyclone unit **114**. Accordingly, cyclone unit **114** may be opened, and dirt chamber **124** may be emptied. The dirt collection chamber **124** is preferably openable both when the dirt collection chamber **124** is mounted to the hand vacuum cleaner, or when it is optionally removed, as will be described hereinbelow. If a plate **124** is provided on the front wall, then when front wall **158** is pivoted away from the remainder of the cyclone unit **114**, separation plate **154** and arm **156** also pivot away from the remainder of the cyclone unit. A latch **159** or other securing member or members may be provided, which secure front wall **158** to wall **115**. In alternate examples, front wall **158** may be removable from cyclone unit wall **115**, or the rear wall **179** of the cyclone unit **114** may be openable or removable. In an alternate embodiment, only the dirt chamber may be removable.

The rear portion of the dirt collection chamber **124** may be closed by wall **179**.

The clean air exiting cyclone **122** passes through outlet **145** of outlet passage **144**, exits surface cleaning head **116**, and passes into the cleaner body **160**. In the example shown, the cleaner body **160** is downstream of the surface cleaning head **116**, and positioned rearward of the surface cleaning head **116**. The cleaner body comprises a suction motor housing **168**, which houses an optional pre-motor filter **162**, a suction motor **164** and may house an optional post-motor filter **166**. As can be seen in FIG. **6**, the air flow passage includes a generally linear airflow path (indicated by arrow A1) between outlet **145** and suction motor **164**. That is, the air flow passage does not comprise significant bends between outlet **145** and suction motor **164**.

In the example shown, suction motor housing **168** further houses a pre-motor filter **162**. One or more filters may be used. Pre-motor filter **162** is provided in the airflow path preferably adjacent and downstream of the outlet passage **144**, and preferably facing the outlet **145**. Pre-motor filter **162** has an inlet **163**, and an outlet **167**. Pre-motor filter **162** serves to remove remaining particulate matter from air exiting the cyclone **122**, and may be any type of filter, such as a foam filter. As can be seen in FIG. **6**, the cyclone unit **114**, the pre motor filter **162**, and the suction motor **164** are arranged linearly.

Suction motor **164** is provided in the airflow path adjacent and downstream of the pre-motor filter **162**. The suction motor **164** may be any type of suction motor. The suction motor draws air into the dirty air inlet **118** of the cleaner **100**, through the airflow path past the suction motor **164**, and out of the clean air outlet **120**. The suction motor **164** has a

motor axis **165**, which is generally parallel to the axis of rotation of a suction fan (not shown) of the suction motor. In the example shown, the motor axis **165** and the cyclone axis **123** extend in the same direction and are generally parallel. Further, in the example shown, the inlet **163** and the outlet **167** of the pre-motor **162** filter are generally transverse to the motor axis **165**. That is, the inlet **163** and the outlet **167** of the pre-motor filter **162** are defined in planes that are transverse to the motor axis **165**.

As shown in FIG. **8**, a downstream end of the suction motor **864** may have an area in a plane transverse to the motor axis **865** and a projection of all of the area in the direction of the motor axis **865** may intersect the clean air outlet **820**. For example, the clean air outlet **820** may have an area in a direction transverse to a direction of air flow through the clean air outlet **820** that is larger than the cross-sectional area of the downstream end of the suction motor **864** in a plane transverse to the motor axis **865**.

The cleaner body **160** preferably further comprises a post-motor filter housing **170**. A post motor filter **166** is provided in the post-motor filter housing **170**. The post motor filter **166** is provided in the airflow path downstream of, and preferably adjacent, the suction motor **164**. The post-motor filter comprises an inlet **169** and an outlet **171**. Outlet **171** is at the rear **110** of cleaner **100**. In the example shown, the plane of the inlet **169** and, preferably in addition, the plane of the outlet **171** are generally transverse to the motor axis **165**. Accordingly, the pre-motor filter air inlet **163**, the pre-motor filter air outlet **167**, the post motor filter air inlet **169** and optionally the post motor filter air outlet **171** are aligned. Post motor filter **166** serves to remove remaining particulate mater from air exiting the cleaner **100**. Post-motor filter **166** may be any type of filter, such as a HEPA filter.

Clean air outlet **120** is provided downstream of post-motor filter **166**. Clean air outlet **120** may comprise a plurality of apertures formed in housing **170**.

In the example shown, cleaner body **160** is preferably removably mounted to surface cleaning head **116**, such as by a bayounet mount, a screw mount or hand manipulateable mechanical fasteners. For example, cleaner body **160** may be entirely removable from surface cleaning head **116**, or pivotally mounted to surface cleaning head **116**. Accordingly, cleaner body **160** and surface cleaning head **116** may be separated in order to provide access to the interior of cleaner body **160** or surface cleaning head **116**. This may allow pre-motor filter **162** to be cleaned, changed, or serviced, or motor **164** to be cleaned, changed or serviced. Alternately, surface cleaning head **116** may be cleaned or serviced. For example, any dirt stuck in outlet passage **144** may be removed. Alternately, a replacement cleaner body **160** or surface cleaning head **116** may be provided, and may be mounted to an existing surface cleaning head **116** or cleaner body **160**, respectively.

One or more additional wheels **180** may be mounted to housing **161**, preferably at lower portion **106**, and may be used in conjunction with wheels **135**. Preferably, a single rear wheel **180** is provided. Preferably, rear wheel **180** is located on a centre line of the vacuum cleaner and rearward of the depending wall **128**.

Referring now to FIG. **8**, in which like numerals refer to like features, with the first digit incremented to 8 to refer to the figure number, an alternate example of a hand vacuum cleaner **800** is shown. In this example, front wall **858** is not pivotally mounted to wall **815**. Rather, wall surface cleaning head **816** is pivotally mounted to body **860**.

Cleaner **800** further comprises a second optional cyclone unit **851** downstream of the first cyclone unit **814**, between first cyclone unit **814** and pre-motor filter **862**. In the example shown, the second cyclone unit **851** comprises a plurality of cyclones in parallel. Each of the plurality of cyclones is parallel to the first cyclone axis **823**. Second cyclone unit **851** has an air inlet **853** and a plurality of air outlets **855**. The direction of flow into the inlet **853** (indicated by arrow A**2**), and out of the outlets **855** (indicated by arrows A**3**) is the same as the direction of flow through the outlet **845** of the first cyclone unit **814** (also indicated by arrow A**2**).

Referring now to FIGS. **9** and **10**, in some embodiments, surface cleaning unit **100** is removably mountable in a surface cleaning apparatus. For example, surface cleaning unit **100** may be removably mounted to form a canister type surface cleaning apparatus, or, as shown, an upright surface cleaning apparatus **900**. Preferably, as shown, surface cleaning unit **100** is usable as a hand vacuum cleaner, as described hereinabove, as well as being removably mountable in a surface cleaning apparatus. In alternate embodiments, surface cleaning unit **100** may be removably mounted in a surface cleaning apparatus, without being usable as a hand vacuum cleaner. For example surface cleaning unit **100** may not be provided with a surface cleaning nozzle **112**, and may serve only as a removable pod of a surface cleaning apparatus.

In the embodiment shown, upright cleaning apparatus **900** comprises a floor cleaning unit **902**, which comprises a surface cleaning head **904**. The surface cleaning head comprises a dirty air inlet **906**. A handle **908** is drivingly connected to the surface cleaning head **904**, such that a user may grip the handle **908** and move the surface cleaning head **904** along a surface to be cleaned.

As exemplified, the surface cleaning unit **100** is connectable in airflow communication with the surface cleaning head **904**. More particularly, the surface cleaning unit is connectable to the surface cleaning head **904** such that an airflow passage extends from the dirty air inlet **906** of the surface cleaning head to the clean air outlet **120** of the surface cleaning unit **100**. For example, as shown, a portion **910** of the airflow passage extends between the surface cleaning head **904** and the surface cleaning unit **100**. The portion **910** comprises a flexible conduit **912**, which in the embodiment shown is hose. An attachment member **914** is provided, which connects the flexible conduit **912** to the cyclone unit **114** of the surface cleaning unit.

Optionally, the surface cleaning head **904** may include one or more electrically powered components, such as, for example an electrically driven rotating agitator brush and/or a headlight. Providing such an electrically powered component may help improve the performance of the surface cleaning head **904** (such as by agitating the underlying surface and/or illuminating the surface to be cleaned). Referring to FIG. **9**, in the illustrated embodiment the surface cleaning head **904** includes a generally forward facing headlight **905**. The headlight **905** may include one or more suitable light emitting sources, including, for example, incandescent light blubs, fluorescent light blubs, light emitting diodes (LEDs) or other suitable sources.

Electrical power may be provided to the surface cleaning head **904** from any suitable source, including, for example, by providing an electrical connection between the surface cleaning unit **100** and the surface cleaning head **904**. Providing an electrical connection between the surface cleaning unit **100** and the surface cleaning head **904** may allow the electrical power provided to the surface cleaning unit **100**,

via on board power source, electrical cord connected to a wall socket (or a combination of both), to be provided to the surface cleaning head **904** without requiring a separate electrical cord that is plugged into an external power source, etc. for the surface cleaning head. Optionally, the flexible conduit **912** is an electrified stretch hose that provides an electrical connection between the surface cleaning unit **100** and the surface cleaning head **904**. In the illustrated example, the flexible conduit **912** includes at least one conductor (e.g. one or more wires) which is illustrated schematically in FIG. **9** using dashed line **907**. Optionally, the conductors may be integrally formed within the walls of the flexible conduit **912**, or may be separate conductors that are affixed to the inner and/or outer surfaces of the flexible conduit **912**. For example, the wires may be provided in a spiral adjacent the resilient member that provides the biasing to a flexible stretch hose.

As exemplified, the surface cleaning unit **100** is removably mounted to and supported by handle **908**, which extends upwardly from the floor cleaning unit **902** and comprises a handgrip **909**. Preferably, handle **908** comprises a mount **914**. In the embodiment shown, mount **914** comprises a U-shaped recess. The attachment member **914** is lockably receivable in the U-shaped recess, to mount the surface cleaning unit **100** to the handle **908** such that, the cyclone unit **114** and the suction motor **164** are supported by the handle **908**.

In the exemplified embodiment, the attachment member **914** mounts the cyclone unit **114** to the handle **908**. In alternate embodiments, any other portion of the surface cleaning unit **100**, such as the motor housing **168**, or the handle **102**, may be mounted to the handle **908**. Further, the portion may be mounted to the handle indirectly, such as via attachment member **914** as shown, or directly. For example handle **102** may be directly received in a mount provided on handle **908**.

As can be seen in FIG. **9**, preferably, when the surface cleaning unit **100** is mounted to the floor cleaning unit **902**, the first cyclone unit **114** is positioned above the suction motor **164**. That is, the suction motor **164** is below the cyclone unit **114**. Accordingly, the front end **108** of the surface cleaning unit **100** becomes an upper end of the cyclone unit **114**, and the openable door **158** is at the upper end of the cyclone unit **114**. When the surface cleaning unit **100** is in this configuration, the linear airflow path between the first cyclone unit **114** and the suction motor **164** is generally vertical and flows generally downwardly.

Preferably, surface cleaning unit **100** is operable both when mounted to the floor cleaning unit **902**, and when removed from the floor cleaning unit **902**. That is, as shown in FIG. **10**, the surface cleaning unit **100** may remain in fluid communication with floor cleaning unit **902**, even when attachment member **914** is removed from mount **914**. As the flexible conduit **912** may provide both the electrical connection and the air flow connection between the surface cleaning unit **100** and the surface cleaning head **904**, in the illustrated configuration, both the air flow connection and the electrical connection between the surface cleaning head **904** and the surface cleaning unit **100** may remain uninterrupted when the surface cleaning unit **100** is removed from the handle **908**. Accordingly, a user may hold handle **102** of surface cleaning unit **100** with a first hand, and hold handgrip **909** with a second hand. This may be useful in cleaning hard to reach locations, or small areas.

Referring to FIG. **11**, another embodiment of a surface cleaning unit **1100** is illustrated. The surface cleaning unit **1100** is generally similar to the surface cleaning unit **100**, and analogous features are identified using analogous reference characters indexed by **1000**. In the illustrated example the surface cleaning unit **1100** is removably mounted to another example of an upright surface cleaning apparatus **1900**. The upright surface cleaning apparatus **1900** is generally similar to the upright surface cleaning apparatus **900**, and analogous features are identified using analogous reference characters indexed by **1000**.

Referring also to FIG. **13**, in the embodiment shown, the surface cleaning unit **1100** is usable as a vacuum cleaner, and more particularly a portable vacuum cleaner. The surface cleaning unit **1100** can be carried and maneuvered by a user by gripping and maneuvering handle **1102** (see also FIG. **15**). The surface cleaning unit **1100** includes a first end **1108**, and a second end **1110** (see FIG. **13**). A longitudinal axis **1125** of the surface cleaning unit **100** extends between the first end **1108** and the second end **1110**. In the example shown, handle **1102** is provided at the first end **1108**. In alternate examples, handle **1102** may be provided elsewhere on the surface cleaning unit **1100**, for example at the second end **1110** or along a sidewall portion, and may be of any design.

In the example shown, the surface cleaning unit **1100** comprises a cyclone unit **1114** that is provided in the airflow passage. Referring to FIG. **13**, the cyclone unit **1114** has a first end **1190**, and a second end **1192**. In the example shown, the cyclone unit **1114** includes one cyclone **1122**, and one dirt collection chamber **1124**, which are separately formed. The suction motor **1164** is positioned above the cyclone **1122**.

In the illustrated example, a single cyclone **1122** is used and the direction of air exiting the outlet of cyclone **1122** is substantially the same as the direction of airflow immediately upstream of the suction motor **1164** (i.e., as it enters the suction motor air inlet). In the illustrated example the air exiting the cyclone air outlet and entering the suction motor inlet travels generally axially, and upwardly as illustrated. The motor has a motor axis **1165**, which in the illustrated example is co-axial with the axis **1125**.

An optional pre-filter **1162**, in a filter housing **1163**, is positioned between the cyclone air outlet **1145** and the suction motor **1162**. Air exiting the cyclone **1122** via the air outlet **1145** is diverted generally radially outwardly into an annular space **1165** formed between the filter housing **1163** and generally cylindrical filter **1162**. Air can then flow generally radially inwardly through the filter **1162** into a generally axially oriented filtered air flow path **1167** of the air flow passage that conveys the air to the inlet of the suction motor **1164**. In this configuration the filter **1162** and housing **1163** have a generally axial configuration, (i.e., they have a longitudinal length between the downstream end adjacent the cyclone outlet and an upstream end adjacent the motor air inlet that extends generally parallel to the motor axis **1165** and the cyclone axis **1123**) and air flowing from the cyclone air outlet **1145** to the inlet of the suction motor **1165** flows in a generally axial direction through the filtered air flow path **1167**.

Alternately, the pre-motor filter may be the same or similar to the pre-motor filter of the embodiment of FIG. **8**. For example, the pre-motor filter may be a foam filter having an upstream face transverse to the cyclone and motor axes.

It will be appreciated that cyclone **1122** may be of any configuration and orientation. Preferably, cyclone **1122** comprises a chamber wall **1142**. The cyclone chamber is located inside chamber wall **1142**. The cyclone **1122** extends along an axis **1123**, which, in the example shown, is generally co-axial with the cleaning unit axis **1125** and the

motor axis **1165**. Axis **1123** preferably extends generally vertically when surface cleaning unit **100** is in an upright storage position (FIGS. **11** and **13**). Cyclone **1122** has a first end **1196**, and a second end **1198** that is spaced from the first end **1196** in the axial direction.

In the illustrated embodiment, the cyclone air inlet **1140** and the cyclone air outlet **1145** are at the same end (first end **1196**) of the cyclone **1122** and the dirt outlet **1146** is at an opposed end (second end **1198**). Optionally, the cyclone air outlet **1145** may be covered by a screen or shroud or filter as is known in the art. As exemplified, the cyclone air inlet **1140** is defined by an aperture in the chamber wall **1142**. The air travels in a cyclonic path in the cyclone **1122**, and dirt in the air is separated from the air.

The dirt that is separated from the air exits the cyclone via dirt outlet **1146**, and enters dirt collection chamber **1124**. Dirt outlet **1146** is preferably at the second end **1196** of the cyclone **1122**, and further, is located generally toward the second **1110** of the cleaning unit **1100**. The dirt collection chamber **1124** may be internal or external to the cyclone chamber. Preferably, as exemplified, the dirt collection chamber is external. The dirt collection chamber **1124** may be in communication with the cyclone chamber **1122** by any means known in the art.

As exemplified in FIG. **13**, in the illustrated embodiment, a plate **1174** is positioned adjacent dirt outlet **1146**. It will be appreciated that plate **1174** may be positioned at any height in dirt chamber **1124**. Preferably, plate **1174** is positioned proximate the top of dirt chamber **1124** and proximate dirt outlet **1146** from cyclone **1122**. Preferably, the minimum distance between plate **1174** and outlet **1146** is at least as large as the largest dimension of the cyclone inlet **1140**. For example, if the cyclone inlet **1140** has a 1 inch height, then the minimum distance between plate **1174** and outlet **1146** is preferably is 1 inch or larger. An advantage of such a design is that any dirt particle that enters the cyclone housing **1142** will be able to pass through the gap into dirt collection chamber **1124**. The distance between the top of plate **1174** and the bottom of the cyclone housing **1142** may be 0.01-2.5 inches and is preferably at least the largest diameter of the cyclone inlet **1140**.

In some embodiments, the plate **1174** may be removable with dirt chamber **1124** from the surface cleaning unit **1100**. An advantage of this design is that plate **1174** defines a partial cover for the dirt collection chamber **1124**. Alternately, the plate **1174** may remain in position when dirt chamber **1124** is removed. In such an embodiment, plate **1174** is preferably attached to the bottom of cyclone housing **1142**.

Referring to FIG. **11**, in the embodiment shown, the upright cleaning apparatus **1900** comprises a floor cleaning unit **1902**, which comprises a surface cleaning head **1904**. The surface cleaning head comprises a dirty air inlet **1906**. A handle **1908** is drivingly connected to the surface cleaning head **1904**, such that a user may grip the handle **1908** and move the surface cleaning head **1904** along a surface to be cleaned.

Referring also to FIG. **15**, in the illustrated example, the surface cleaning unit **1100** is removably mounted to and supported by handle **1908**, which extends upwardly from the floor cleaning unit **1902** and includes a handgrip **1909**

As can be seen in FIG. **11**, preferably, when the surface cleaning unit **1100** is mounted to the support member **1920** and is in the storage position, the cyclone unit **1114** is positioned below the suction motor **1164**. That is, the suction motor **1164** is above the cyclone **1122** and the dirt collection chamber **1124**. When the surface cleaning unit **1100** is in this configuration, the substantially linear airflow path between the first cyclone unit **1114** and the suction motor **1164** is generally vertical and flows generally upwardly.

In the illustrated example, the surface cleaning unit **1100** is operable both when mounted to the floor cleaning unit **1902**, and when removed from the floor cleaning unit **1902**. Accordingly, a user may hold handle **1102** of surface cleaning unit **1100** with a first hand, and hold handgrip **1909** with a second hand. This may be useful in cleaning hard to reach locations, or small areas.

As exemplified, the surface cleaning unit **1100** is connectable in airflow communication with the surface cleaning head **1904**. More particularly, the surface cleaning unit **1100** is connectable to the surface cleaning head **1904** such that an airflow passage extends from the dirty air inlet **1906** of the surface cleaning head to the clean air outlet **1120** of the surface cleaning unit **1100**. For example, as shown, a portion **1910** of the airflow passage extends between the surface cleaning head **1904** and the surface cleaning unit **1100**. The portion **1910** comprises a flexible conduit **1912**, which in the embodiment shown is hose. An attachment member **1914** is provided, which connects the flexible conduit **1912** to the cyclone unit **1114** of the surface cleaning unit.

In the illustrated embodiment, a support member or spine **1920** is mounted to the surface cleaning head **1904**, and a mounting member **1922** is mounted to the support member **1920**. At least two operating components of the surface cleaning unit **1100** are mounted directly or indirectly to the mounting member **1922**. When the illustrated apparatus is in use, fluid enters surface cleaning head **1904** via dirty fluid inlet **1906** and is directed upwards into the at least one cleaning stage via an upflow duct **1924**. In the illustrated embodiment, the support member **1920** comprises upflow duct **1924**. That is, support member **1920** provides at least a portion of the air flow passage between surface cleaning head **1904** and surface cleaning unit **1100**. In other embodiments, upflow duct **1924** may be a separate member. For example, upflow duct **1924** may be a conduit that is affixed to support member **1920**. In the embodiments shown, support member **1920** is pivotally mounted to surface cleaning head **1904** via a pivoting connector **1926**.

In the embodiments shown, support member **1920** extends upwardly towards mounting member **1922**. Mounting member **1922** serves as a support for the surface cleaning unit **1100**. In the preferred embodiment, cleaning stage **1100** is directly or indirectly mounted to mounting member **1922**, as will be described further hereinbelow. In some embodiments, mounting member **1922** may be integrally formed with support member **1920**. In other embodiments, as shown in FIGS. **13** and **14**, mounting member **1922** may be integrally formed as a component of the surface cleaning unit **1100**. In other embodiments, mounting member **1922** may be a separate member. As exemplified, mounting member **1922** may form a portion of the air flow path (see for example FIG. **12**) or it may not include a fluid flow path therethrough.

In embodiments wherein support **1920** comprises upflow duct **1924**, mounting member **1922** may further serve to connect support **24** in fluid communication with cyclone unit **1114**. That is, mounting member **1922** may comprise an airflow passage **1928** (FIG. **12**). In alternate embodiments (not shown), a mounting member may not be provided, and support **1922** may be mounted directly to the cyclone uint **1114**. In further alternate embodiments, wherein upflow duct **1924** is a separate member, a mounting member may not be provided, and upflow duct **1924** and support **1920** may be mounted directly directly to cyclonic unit **1114**. In the

embodiments shown, air passes from the cleaning head **1904**, into mounting member **1922**, and from mounting member **1922** into cyclonic unit **1114**.

In accordance with another aspect of this invention, which may be used by itself or with any other aspect, the surface cleaning apparatus **1900** comprises the first dirty air inlet **1906** and a second or auxiliary dirty air inlet **1932** (FIG. **15**), which are selectively connectable in fluid flow communication with surface cleaning unit **1100**. Preferably, surface cleaning unit **1100** is operable in a floor cleaning configuration (in which the dirty air inlet **1906** is in use) and one or more above floor cleaning configurations (in which the auxiliary dirty air inlet is in use). More preferably, the surface cleaning unit **1100** is operable in at least two above floor cleaning configurations.

Surface cleaning apparatus **1900** may be converted from a floor cleaning mode (FIG. **11**) to an above floor cleaning mode (FIGS. **14** and **15**) by rotating an airflow valve **1934** provided in mounting member **1922**. In the floor cleaning mode, valve **1934** connects upflow duct **1920** to cyclone inlet **1140** such that air travels from first dirty fluid inlet **1906** in surface cleaning head **1904** to cyclone inlet **1140**. When valve **1934** is rotated to the other position, and elongate wand extension **1936** is removed from mounting member **1922**, air travels from second dirty air inlet **1932** through wand **1936**, to flexible hose **1912**, and past valve **1934** to cyclone inlet **1140**. Accordingly, in this embodiment, the first **1906** and second **1932** dirty fluid inlets are respectively in flow communication with first **1938** and second **1940** airflow passages, which merge at a position proximate the inlet of the cyclone **1122**. One advantage of this design is that a simplified structure for converting a surface cleaning apparatus **1900** to an above cleaning mode is provided. In addition, as valve **1934** is provided in mounting member **1922**, and therefore a few feet above the floor, then a user need not bend down to rotate valve **1934** between the floor cleaning position and the above floor cleaning position. In other embodiments, valve **1934** may be affixed to the handle **1909** or support member **1920**.

In the embodiment shown, mounting member **1922** comprises a body **1942** having an upper portion **1944** and a lower portion **1946**. Lower portion **1946** defines an opening **1948** (FIG. **12**) for receiving an upper end of support member **1920**. Upper end of support member **1920** may be securely mounted in opening **1948** by any means, such as by an adhesive, a friction fit, a set screw or the like. In embodiments wherein support member **1920** comprises upflow duct **1924**, opening **1948** may be in fluid communication with a cyclone chamber inlet **1140**. In the embodiment shown, the upper portion **1944** of mounting member **1922** comprises a second opening **1952** to receive a lower end **1954** (FIG. **14**) of the wand **1936**, which supports handle **1909**. Lower end **1954** may be secured in second opening **1952** by any means known in the art.

In accordance with another aspect of this invention, which may be used by itself or with any other aspect or aspects, surface cleaning apparatus **1900** is convertible to a portable surface cleaning apparatus. That is the surface cleaning unit **1100** is convertible to a portable cleaning and suction unit. Referring to FIG. **15**, surface cleaning unit **1100** can be provided with a shoulder strap **1942**. In order to convert the surface cleaning apparatus **1900** to a portable surface cleaning apparatus, the user may unwind shoulder strap **1942** and extend it across their shoulder. The surface cleaning unit **1100**, including mounting member **1922**, may be removed from support member **1920** by, for example, actuating a release catch and lifting the surface cleaning unit **1100** off of support member **1920**, for example using handle **1102**.

One advantage of the embodiments described above is that the volume of the cleaning apparatus may be reduced. In particular, in the embodiments shown, the outer surfaces of one or more of the cyclone chamber wall **1142**, motor housing **1168**, filter housing **1163**, and dirt chamber **1124** may be visible when surface cleaning apparatus is in use (except for the portions facing support member **1920**). Accordingly, the overall volume of the vacuum cleaner is reduced. In addition, the weight of the vacuum cleaner is also substantially reduced. In particular, the amount of plastic that is typically used to construct an upper casing of a cyclonic vacuum cleaner that receives a removable cyclone chamber or dirt chamber substantially increases the weight of the vacuum cleaner. In the embodiments shown, surface cleaning unit **1100** may weigh 10 lbs. or less (without the cord) and, preferably less than 8 lbs.

A further advantage of the embodiments shown is that, if the elements of cleaning unit **1100** are removably mounted to each other and to mounting member **1922**, cleaning unit **1100** may be easily disassembled for cleaning. In addition, if a component needs to be replaced, the user may merely acquire the required component (e.g. by purchasing it at a store or on line) and replace the faulty component. For example, if motor **1164** fails, pursuant to a warranty plan, the manufacturer may merely ship the required motor housing **1168** and motor **1164** to the customer who may remove (e.g., unscrew) the motor housing **1168** having the faulty suction motor **1164** and replace it with the new replacement part.

A further advantage of this design is that filter chamber **1163** may be accessed for removal (for cleaning or replacement) by disassembling a portion of the cleaning unit **1100**. For example, filter chamber **1163** may be accessed by removing motor housing **1168** from the cleaning unit **1100**. Accordingly, a door or the like is not required in filter chamber **1163**, thereby simplifying the construction of filter chamber **1163**.

While the above description provides examples of the embodiments, it will be appreciated that some features and/or functions of the described embodiments are susceptible to modification without departing from the spirit and principles of operation of the described embodiments. Accordingly, what has been described above has been intended to be illustrative of the invention and non-limiting and it will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto.

The invention claimed is:

1. A surface cleaning apparatus comprising:

an air flow passage extending from a dirty air inlet to a clean air outlet;

a surface cleaning head having the dirty air inlet, the surface cleaning head having a pivoting connector;

a support pivotally mounted to the surface cleaning head by the pivoting connector;

a surface cleaning unit vertically removably mounted to an upper end of the support, the surface cleaning unit comprising:

(i) a cyclone unit positioned in the air flow passage, the cyclone unit comprising a cyclone chamber having a cyclone air inlet, a cyclone air outlet, a dirt outlet and a dirt collection chamber external to the cyclone chamber;

(ii) a pre-motor filter positioned in the air flow passage downstream from the cyclone air outlet;

(iii) a suction motor positioned in the air flow passage downstream from the pre-motor filter; and,

(iv) a flexible hose

wherein, when the surface cleaning unit is mounted to the support and the support extends vertically, the cyclone unit is mounted to an upper end of a suction motor housing and the surface cleaning unit is in a storage orientation and

wherein the cyclone unit is removably mounted to an upper end of the suction motor housing, and

wherein, when the surface cleaning unit is in the storage orientation, the cyclone unit has an openable upper end and, when the upper end of the cyclone unit is opened, the cyclone chamber and the dirt collection chamber are concurrently opened, and

wherein, when the surface cleaning unit is in the storage orientation mounted, the cyclone air inlet and the cyclone air outlet are provided at a lower end of the cyclone chamber and a dirt outlet is provided at an upper end of the cyclone chamber.

2. The surface cleaning apparatus of claim **1** wherein, in one portable mode, the surface cleaning unit remains in air flow communication with surface cleaning head as the surface cleaning unit is removed from the support.

3. The surface cleaning apparatus of claim **1** wherein, when the surface cleaning unit is mounted to the support and the support extends vertically, the surface cleaning unit overlies the surface cleaning head.

4. The surface cleaning apparatus of claim **3** wherein the dirty air inlet is provided at a front end of the surface cleaning head and, when the surface cleaning unit is mounted to the support and the support extends vertically, a rear side of the portable cleaning unit is mounted to the support and the portable cleaning unit is positioned forward of the support.

5. The surface cleaning apparatus of claim **1** wherein the dirt collection chamber comprises a portion that is positioned radially outwardly of the cyclone chamber.

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